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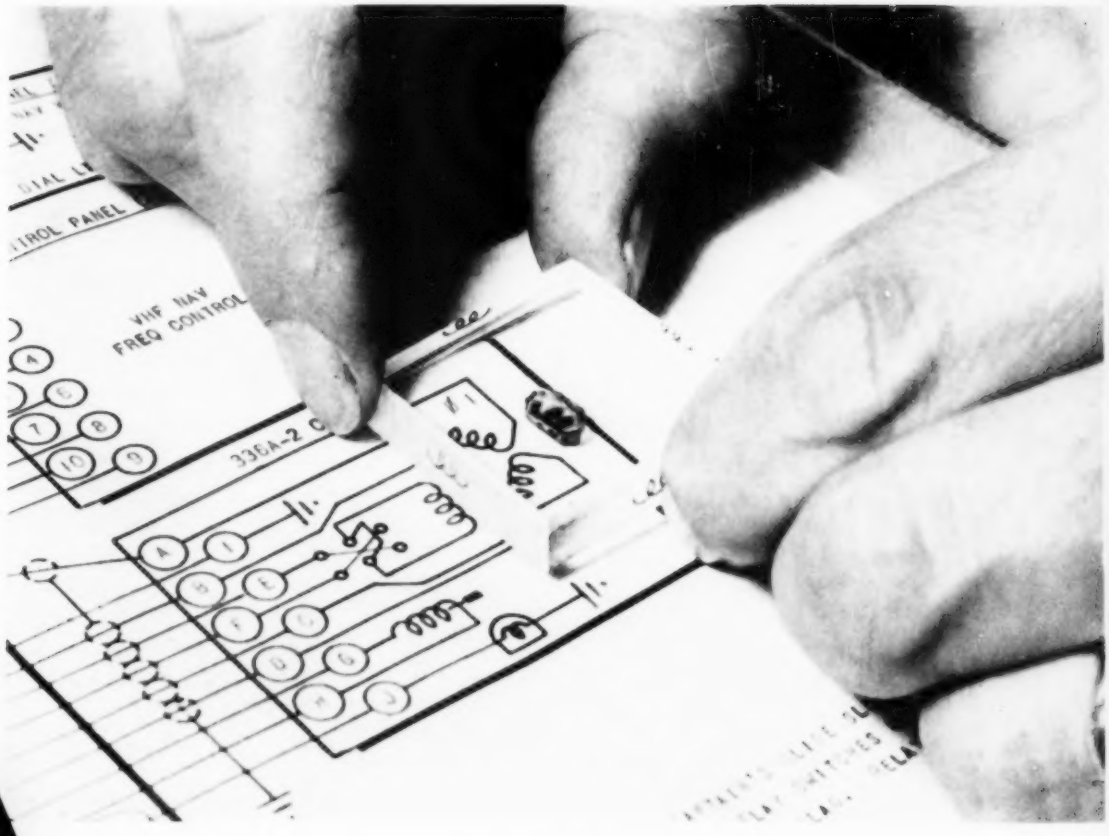

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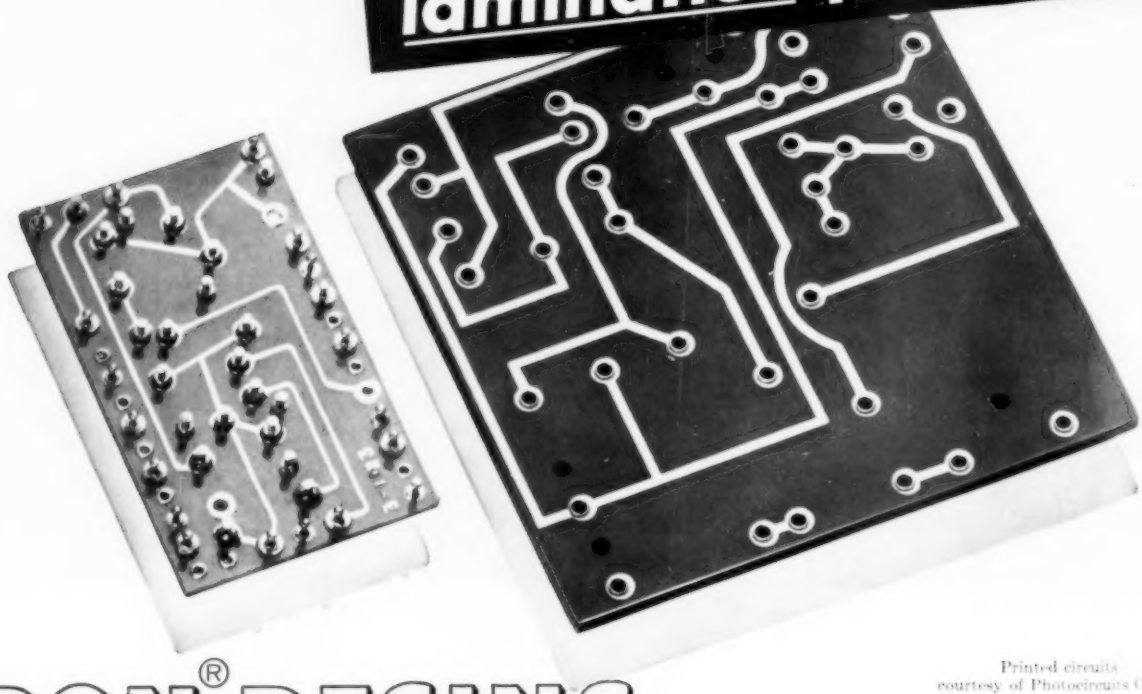

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Across the Editor's Desk

PLASTICS MAGAZINES

Last January we printed a list and description of all the plastics magazines printed, and in the list was International Plastics, the first issue of which had not yet been published. We are now getting copies of the magazine, and the name turns out to be Osterreichische Plastic-Rundschau. First issue was January 1953. The magazine is printed in German, and is issued monthly from Player and Co., Vienna 6, Austria, subscription price 22 Deutches Marks. Articles, news notes and new applications make up the content of the February issue, which is 16 pages and cover.

Far as we know there is only one other plastics magazine being published that we haven't told you about. It's being printed in Brazil, and we should be abstracting it by September. More news when we get our first copy.

EDITORIAL ADVISORY BOARD

We suggest you take a look under the masthead and read the names of our Editorial Advisory Committee. Pretty impressive, isn't it? The SPE Journal is fortunate to have the advice of these eminent gentlemen in screening articles for your reading. This committee is now twice as large as it was at the start of the year, and we have available expert advice in every field. Every paper is read and commented on by at least three men on the board. In case you ever wondered, about half of the papers submitted to the Journal get printed.

We want to extend our thanks to J. H. DuBois and Carl Frosch who served on the Advisory Board for many years, both of whom resigned this year. Their generous and careful work has been a great help to your editor.

BIOLOGY

The lot of an editor is not always the happiest in the world. Witness our confusion and dismay on receiving several letters protesting an article we had thought very interesting, **The Biology of Plastics** which appeared in our January issue. The principle point of objection concerned the description of certain plastic items which were tested and found toxic. The important thing, which apparently was not too clear, is that these tests described in the article were **all carried out on new materials or formulations,** for just exactly the purpose that **no** item should ever reach the public which is in any way harmful. Such items were **never** put on the market precisely **because of** such test results.

Detroit Meeting Schedule

June 23rd, Tuesday: Golf—Grosse Ile Golf and Country Club.

Sept 22nd, Tuesday: Golf—Glen Oaks Country Club.

Oct. 19th, Monday: Dinner and Technical Meeting—Rackham Memorial Building.

Nov. 20th, Friday: Dinner, Technical Meeting and Turkey Raffle (This is the Friday before Thanksgiving) Place to be announced at a later date.

Dec. 11th, Friday: This meeting is the big affair of the year, we will have a semi-formal affair for members, customers, friends and their wives. All of the details to be announced at a later date. It will be held either at the Park Sheraton or Sheraton Cadillac Hotels.

As in previous years, we will have beautiful gifts galore especially for the wives.

Three Questions And An Answer

What can the younger man working in the plastics industry do to accelerate his upward progress? How can he present his original ideas and theories to the men in the plastics industry?

How can management and industry recognize the new-comer with real talent, ideas, initiative? This is the same as the first question, isn't it?

And what of the more experienced man, whose ideas stem from experience and mature judgment; the engineer who is not a professional writer? Shouldn't he be encouraged to publish his ideas, for the good of the plastics industry?

The answer to these questions lies in the SPE constitution, which says that The Society of Plastics Engineers is a national engineering society with a membership comprised entirely of individuals, the objects of which are to promote in all lawful ways the Arts, Sciences, Standards and Engineering Practices connected with the use of plastics.

The SPE PRIZE PAPER CONTEST was decided on eight years ago to provide a forum for the presentation of ideas and experience, to provide recognition for men with initiative, for the good of the plastics industry.

Who can enter the contest? Anybody! Members of SPE or not; residents of the U. S. or any foreign country, everyone. Anyone with ideas, whether they be novel or based on experience.

What topics could a paper be written on? The field is wide open, with no restrictions, because no one knows from what direction a real contribution will come next. Let's make a little list, following the history of a plastic from inception to end-use. The chemistry and physics of monomers, or of the polymers; means of producing or modifying polymers; properties and uses of fillers, dyes, blends and so on; molding methods, extrusion methods, molding conditions; mold design and mold materials; product design; the design, use, maintanence of molding machines and auxiliary equipment; coloring of plastics; tests and testing equipment and interpretation of test data for plastics; use of quality control procedures; ideas for sales techniques, new applications, accounting practices peculiar to the plastics business; other methods of forming such as vacuum forming, fabricating, ways of sticking plastics pieces together, surface treatments; plant layout and materials handling; any and all of these general topics are eligible, as well as a hundred others you could name. The only restriction on the paper is that it deal with some phase of the plastics business.

Of course there have to be some limitations; the paper must be original, and all references cited; the paper must not have been previously published or be committed for publication elsewhere, since it becomes the sole property of the SPE. Prize winning papers are published in the SPE Journal, and may then be published elsewhere. Papers not printed in the Journal may be published elsewhere on permission of the SPE.

Interested? Here's how the contest is run. Each paper must be submitted first to the SPE Section of which you are a member, or if you are a nonmember to the geographically nearest Section (if in doubt, send paper to the SPE National Office for placement). The papers in each Section are judged for local prizes. The local prize-winners are then sent to the National SPE Prize Paper Contest Committee, headed this year by Mario Petretti, for final judging. National prizes are two hundred, one hundred, and fifty dollars, plus an engraved certificate. Decisions of the judges are final.

There is no restrictions on the length of the paper; a short paper has as good a chance as a long one, but may be of any length. For submission to the National Contest, five copies of the paper should be submitted, to facilitate judging. All graphs and drawings should be in India ink on tracing paper or a good quality of white paper for the original copy of the paper; reproductions may be used for duplicate copies of the papers.

When does the contest end? Well, better write that paper as soon as possible. Don't wait till the last minute (October 15, 1953).

What have you got to lose? A little time. What have you got to gain? Recognition for service to the plastics industry, and just possibly a couple of hundred dollars.

Looked into Your Future Lately?

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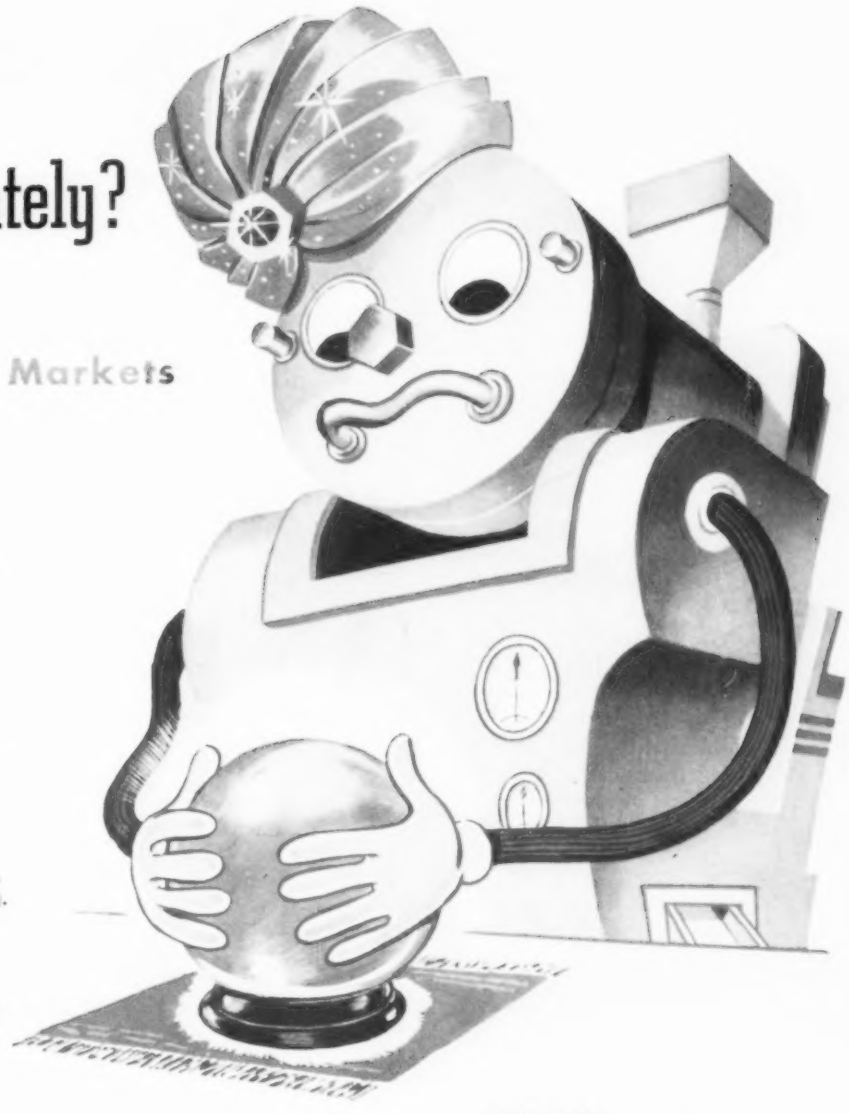

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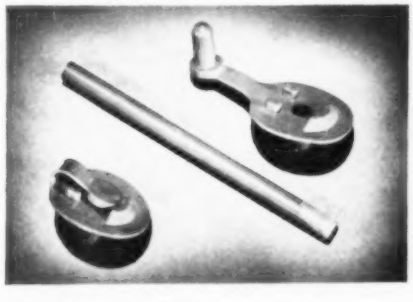

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The Flow of Plastics Melts Through Dies

J. P. Tordella

Research Division, Polychemicals Dept.
E. I. du Pont de Nemours and Co., Inc.

A TECHNICAL SYMPOSIUM Paper
Presented at the Ninth SPE Conference

The equation of flow of viscous liquids through circular dies is well known. This equation is most useful in making engineering calculations of flow rates of viscous liquids, but large errors are involved if it is applied to plastics melts.

In this paper the flow behavior of plastics melts in dies is discussed. Approximate flow equations are given along with constants for various plastics. Flow behavior of plastics melts is discussed in terms of simple molecular concepts and a mechanical model.

I. EFFECT OF SHEAR RATE AND TEMPERATURE ON VISCOSITY

NEWTON, in 1685, proposed the following hypothesis. Assume a layer of liquid between two plates (Figure 1) whose area is A, which are separated by distance d. If force F is applied in the plane of the upper plate, then the plate will move in the direction of the force with a given velocity. The velocity will be proportionate to the force, F, and the distance between the plates. The velocity will be inversely proportionate to the area of the plates and to a constant of the material, its coefficient of viscosity or resistance to shear.

$$V = \frac{Fd}{A\mu} \tag{1}$$

For small deformations equation (1) may be written in terms of shear rate, v/d, and shear stress, F/A:

$$\frac{V}{d} = \frac{F}{\mu A} \tag{2}$$

This experiment was never performed since liquids will not remain uncontained on plates. However, Poiseuille found that the flow-rate of a liquid in a tube was directly proportional to the pressure drop across the tube. Mathematicians formulated Poiseulle's law:

$$Q = \frac{\pi r^4 P}{8 l \mu} \tag{3}$$

where: Q is the flow-rate; r, the radius of the tube; P, the pressure[1]; l the length and μ the coefficient of viscosity. This equation may be rewritten in terms of the maximum shear rate, $4Q/\pi r^3$, and shear stress $Pr/2l$ at the wall of the tube:

$$\frac{4Q}{\pi r^3} = \frac{1}{\mu} \cdot \frac{Pr}{2l} \tag{4}$$

Equations (2) and (4) are equations of a straight line (Figure 2) whose slope is reciprocal viscosity.

In Newton's sliding plate experiment there is a uniform velocity gradient or shear rate between the plates. In a tube or round die the shear rate and likewise the shear stress vary from zero at the center to a maximum at the wall of the tube. As a result the velocity profile across a tube is parabolic (Figure 3). This has been demonstrated many times by measurements of interfaces between clear and colored liquids flowing in tubes.

The Poiseuille equation is widely used in calculation of viscous flow-rates of Newtonian fluids in circular channels. This equation has been extended to channels of other cross-sections (Ref. 1). However, the Poiseuille equation fails when applied to the flow of plastics melts in dies, particularly at the rates of shear used in commercial fabrication operations.

There are fundamental differences between Newtonian fluids and plastics melts. Plastics are composed of very large molecules which are synthesized from many hundreds or thousands of small molecules. The small molecules may be compared to grains of sand and the giant molecules to lengths of thread [2]. These thread-like molecules are not arranged in an orderly fashion but are randomly bent, intertwined, and tangled.

The flow properties of plastics melts which have a "tangled-thread" type of structure are much different from those of simple, more spherical molecules. In shear, the long molecules tend to bend and slide, and orient in the direction of the stress. The orientation results in decreased resistance to flow or decreased viscosity. The pro-

[1] *Pressure is used throughout instead of pressure drop across the orifice, ΔP.*

[2] *It would be more suitable to compare the structure of the giant molecules to the branch structure of a tree because such molecules are often not linear.*

cess reaches its limit at a given stress rather rapidly so that no time dependence of viscosity is usually noted in a die. However, the amount of orientation increases with increasing shear rates. Consequently viscosities of plastics melts are not constant at constant temperature but depend on shear rate. The equations of Newton (2) and Poiseuille (4) which assume constant viscosity are not valid for plastics melts.

The velocity profile of a plastic melt in a die is not parabolic as is the case for Newtonian liquids. As a result of the dependence of viscosity on shear rate, the viscosity varies from a maximum at the center, where the shear rate is zero, to a minimum at the wall where the shear rate is a maximum. The combined effect of change in shear stress across the die and change of viscosity with shear rate results in a velocity profile similar to an ellipse sectioned through its minor axis (Fig. 4). (The dotted line shows the parabolic profile of a Newtonian liquid.) The higher the shear stress pushing the melt through the die, the more elongated and more blunted does the velocity profile become.

OTHER FACTORS

There are two other factors which may affect the velocity profile across a die. The orientation of the molecules may not be instantaneous but may continue to some extent as the melt flows down the channel. This results in more and more elongated velocity profiles down the length of the die. The high shear at the edges of the die raises the temperature of the melt [3]. This is accompanied by further reduction of viscosity at the edges and further increase in velocity near the walls of the die.

A typical flow curve for a plastic melt is shown in Fig. 5. The broken line indicates Newtonian flow. The actual curve for a plastic departs from linearity at rates of shear below ten reciprocal seconds and has a continuously increasing slope. The flow could again become Newtonian at some high rate of shear sufficient to produce complete orientation of the molecules. However, this is not reached in practice.

There are numerous equations (2, 3, 4) which have been suggested in place of the Poiseuille equation to describe the flow-rate of plastics melts. The simplest of these is the "power law." The power law has a number of disadvantages. It is not applicable over a wide range of shear rates, and it is empirical. However, the power law is simple and for many purposes adequate.

The power law postulates a proportionality between the flow-rate and the pressure raised to some power greater than one:

$$Q = KP^c \tag{5}$$

where Q is flow-rate; K, a constant involving the characteristics of the plastic, and dimensions of the die; P, the pressure; and c, an exponent greater than one. Equation (5) may be written in terms of shear rate and shear stress and the dimensions of the die. For circular orifices it is

---

Crude measurements were made of the effect of shear on temperature of "Alathon" 1 polyethylene resin in a thin wall 0.085" diam., 1.125" long die. At a stock temperature of 379°F, the temperature of the wall of the die (wall thickness .020") was: 432°F at a flow rate of 0.25 lb./min.; 414°F at 0.13 lb./min.; 410°F at 0.075 lb./min.

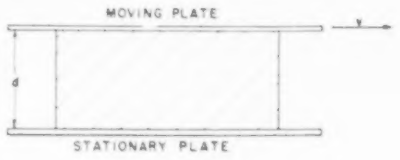

FIG. 1 THE NEWTONIAN MODEL OF FLOW

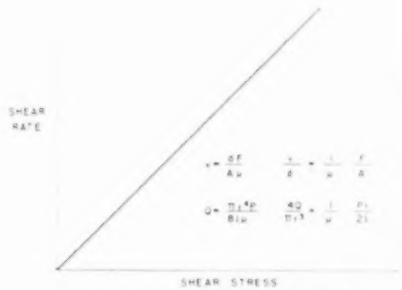

FIG. 2 FLOW CURVE FOR NEWTONIAN LIQUID

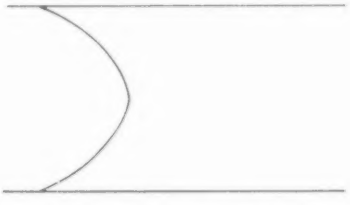

FIG. 3 VELOCITY PROFILE OF A NEWTONIAN LIQUID IN A TUBE

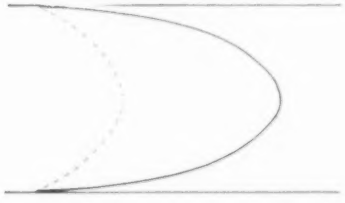

FIG. 4 VELOCITY PROFILE OF A PLASTIC MELT IN A TUBE

FIG. 5 FLOW CURVE FOR A PLASTIC MELT

(6) $$\frac{(c+3)Q}{\pi r^3} = k\left(\frac{Ph}{2L}\right)^c$$

(7) $$\frac{(c+2)Q}{4bh^2} = k\left(\frac{Ph}{L}\right)^c$$

given in equation (6), and for slit dies in equation (7) [4]. In both of these equations the quantity on the left side of the equality is the approximate maximum rate of shear at the wall; k is a constant of the material; the quantity within the brackets on the right side of the equality, the shear stress; and c is an exponent greater than one. In equation (7) b is the half width of the slit; h, the half height and L, the length of the land.

In equation 6, h is the radius of the orifice.

Equations (5, 6, and 7) postulate a linear relation between the logarithm of the shear rate and the logarithm of the shear stress of a slope greater than one (Fig. 6). These equations fit the data for most thermoplastics at shear rates between 10 and 1000 reciprocal seconds well enough for most practical work.

The effect of temperature on the flow-rates of plastics melts is described fairly well by the equation

$$Q = Ke^{-E/RT}$$

where E is the so called activation energy for viscous flow; R, the gas constant; and T, the absolute temperature. This equation is not a perfect fit but, again, it works well over the practical range of working temperatures for the common thermoplastics.

Constants for use in equations (5, 6, 7, and 8) for polyethylene, nylon, acrylic and polystyrene resins are given in the table below. These constants were calculated from data obtained in a small piston plastometer operated at shear-rates in the range 1 to 10^5 sec^{-1}. The plastometer cylinder was 0.375" in diameter and the die 0.031" in diameter and 0.503" long. The temperatures at which the values of k for equations (5) and (6) were determined appear in parenthesis below the value.

Using the exponent of 2.6 for "Alathon" 1 polyethylene resin as given in Table I, the effect of doubling the pressure on the through-put in a film extrusion process may be calculated. The through-put will increase by a factor of $2^{2.6}$, or by a factor of about six. The Poiseuille equation, if applied in this case, would predict only twice the initial through-put.

Actual data for "Alathon" 1 polyethylene resin are shown in Fig. 7 and given in Table II. The power law [equation (5)] postulates that the log pressure log flow-rate curves should be linear. They are almost linear in the middle two orders of magnitude of flow-rate. Since a large amount of commercial fabrication is done at rates of shear corresponding to these flow-rates, the power law is at least a useful approximation. Equation (8) indicates that

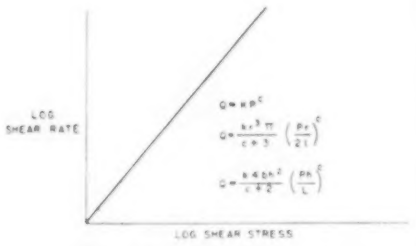

FIG. 6 FLOW CURVE FOR A PLASTIC MELT

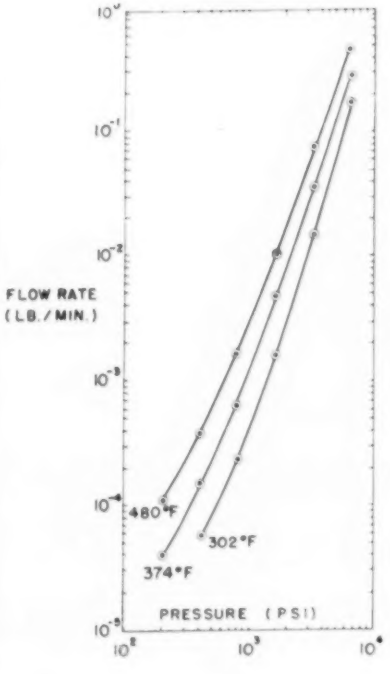

Figure 7. Flow data for "Alathon" 1 Polyethylene Resin

TABLE I

Flow Constants for Various Plastics Melts

	k (in² ÷ sec)*	c	E (kcal/mole)
"Alathon" 1 polyethylene resin	3.35×10^{-8} (482°F)	2.6	8.1
Nylon resin FM-10,001	2.56×10^{-2} (554°F)	1.6	12
"Lucite" acrylic resin HM-140	3.38×10^{-9} (464°F)	2.6	39
Polystyrene resin	1.14×10^{-8} (518°F)	2.7	16

*These units are square inches per pound force second.

TABLE II

Flow Data for "Alathon" 1 Polyethylene Resin (Orifice Diameter 0.031", Length 0.503")

Hydrostatic Pressure (psi)	Flow Rate (in³/min.) 302°F	374°F	480°F
205	–	3.96×10^{-5}	1.10×10^{-4}
411	5.74×10^{-5}	1.52×10^{-4}	3.86×10^{-4}
822	2.73×10^{-4}	6.47×10^{-4}	1.68×10^{-3}
1643	1.64×10^{-3}	4.51×10^{-3}	1.03×10^{-2}
3286	1.52×10^{-2}	3.56×10^{-2}	7.63×10^{-2}
6573	1.75×10^{-1}	2.80×10^{-1}	4.72×10^{-1}

[4] *From unpublished correspondence of J. E. Guillotte, E. I. du Pont de Nemours & Co., Polychemicals Dept., Production Division, Technical Section.*

...s should be parallel and have a given spacing. These conditions, too, are approximated by the data in the middle two orders of flow rate.

II. EFFECTS OF ELASTICITY

There are some flow characteristics of plastics melts which are not explained merely by the dependence of viscosity on shear rate and temperature. Plastics melts have considerable elasticity. Evidences of this are: the rubber-like elasticity of a length of molten beading when stretched and relaxed; swelling of a beading or film after leaving the die with the result that final dimensions are larger than die dimensions; spider marks on extruded tubing; and residual stress in extruded and injection molded articles. When polymer molecules are displaced from their random positions by shear, they do not "forget" their original configurations immediately. Probably only relatively small segments of the molecules assume new positions during flow. The ends of the molecules stay in roughly the same environment and exert restoring forces. These forces tend to make the melt revert to the configuration it had before flow occurred.

A mechanical model shown in Fig. 8 may be used to describe the behavior of plastics melts under a shear stress. It is composed of perfect springs and dashpots. The springs are elastic components and the dashpots, viscous components. When a weight is hung on the model, the upper spring deflects immediately giving an instantaneous deformation of a fixed amount depending on the force. The fluid in the lower dashpot flows at a steady rate depending on the viscosity of the melt. The parallel spring and dashpot combination[5] deflect at an ever-decreasing rate until the spring reaches the full extension associated with the load. The dashpot damps the spring. The time constant or relaxation time of this parallel spring and dashpot determines the time required for the weight to reach a steady rate of motion or the time required for the stresses in a melt to relax after a given strain has been imposed.

The time dependence of the velocity of the sliding plate (Fig. 9) in Newton's hypothetical experiment with a plastic melt between the plates may be analyzed in terms of the mechanical model. The intercept on the ordinate in Fig. 9 is the instantaneous elastic deformation which occurs when the shear stress is applied. The nonlinear section between t=0 and t=1 is a combination of delayed elastic deformation, and damped motion of the parallel spring and dashpot; and viscous deformation, the motion of the lower dashpot. The linear portion between t=1 and t=2 is pure viscous flow, motion of the lower dashpot, which occurs after the parallel spring and dashpot reach their limiting extension. When the load is removed, t=2, the immediate recovery is the recovery of the spring, and the nonlinear section, the recovery of the parallel spring and dashpot. The permanent deformation is the extent of the pure viscous flow.

A similar treatment for behavior of a plastics melt in a die is not possible since the melt may not remain in the die long enough for the delayed elastic deformation to go to completion. The apparent viscosity of a melt may keep changing as the material goes down the die and thus will vary with dwell time in the orifice. This is one reason equations 5 and 6 are not completely independent of die dimensions.

The elastic elements of the mechanical model and the corresponding parts of the deformation-time curve illustrate the orgin of elastic effects in plastics. The magnitude of the elasticity and its time dependence are functions of

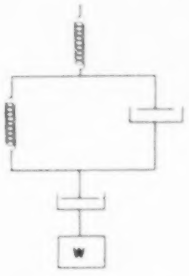

FIG.8 MECHANICAL MODEL OF PLASTICS MELTS

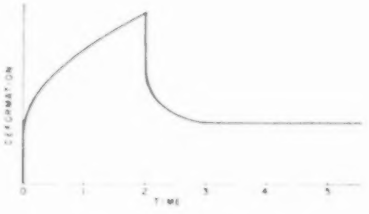

FIG. 9 DEFORMATION AND RELAXATION OF PLASTICS MELTS

the plastics themselves. The magnitude of the elastic effects during fabrication may be minimized by judicious selection of fabrication conditions, i.e., high temperature and low rate.

In summary, plastics melts are far from being simple Newtonian liquids. Plastics melts have a pronounced dependence of viscosity upon shear-rate and have considerable elasticity. These properties are related to molecular structure and may often be explained qualitatively on the basis of a simple mechanical model.

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DuBois Appointments

DuBois Plastic Products, Inc., 170 Florida Street, Buffalo, New York announce the appointment of Richard R. VanGeem as Chief Engineer. Mr. VanGeem, formerly in charge of plastic molding operations at Trico Products Corporation, is a veteran of seventeen years in the molding industry. He is an active member of the Buffalo Section of Plastics Engineers.

Mr. Raymond C. Confer, formerly Chief Engineer, is now Assistant General Manager of the Company.

Recent exparsions of production facilities at DuBois includes the addition of three eight-ounce Reed-Prentice injection machines for the Company's nylon molding department, a 48-inch full-automatic Fiberglas preformer in their reinforced-plastics department, and additional machine-tool equipment in their die shop.

Mr. N. J. Taylor is president of the Company and Mr. R. A. Bright is General Manager.

In this model the lateral tie bars always remain horizontal.

A. P. Landall

Engineering Design

A. P. Landall

Chemical Materials Department
General Electric Company

A TECHNICAL SYMPOSIUM Paper
Presented at the Ninth SPE Conference

During the last five years since the initial introduction of the rubber-phenolic materials, there has been a steady growth of these materials for special jobs which could not be satisfactorily accomplished by the more conventional phenolics. The activity in this field has necessitated the development of new design concepts. Certain ideas regarding the design and methods of handling which were thought necessary in the early days of the rubber-phenolics have been found to be unnecessary and, in some cases, even erroneous. Other of the initial concepts are still true and pertinent today. Some molders have been disturbed by the fact that certain engineering data have not been available and, too, the use of this material has necessitated new handling techniques. It is the purpose of this paper to discuss the design concepts necessary to use these rubber-phenolic materials properly and to illustrate these concepts by applications and molding methods.

ANY ENGINEERING discussion of a material necessitates some discussion of properties. Figure 1 shows the comparison of properties between the woodflour-filled rubber-phenolics and its conventional counterpart. Notice the difference in the modulus of elasticity. It is this lowering of the modulus which accounts in large part for the unique properties of this material. Notice, too, that the impact strength, although higher than the conventional counterpart, is not as high as might be expected. The izod impact does not show the true impact of this material. The drop impact test shows this material in its true relationship. Notice that now the fatigue impact of the rubber-phenolic appears to be 5 times that of its conventional counterpart. This relationship has been borne out by many practical applications. The same general relationship holds between rubber-phenolics with other fillers and their conventional counterpart.

DESIGN DATA

Perhaps the first consideration is one of shrinkage. The normal general purpose material is generally considered to have a mold shrinkage for design purposes of .007 to .008 inches per inch. The rubber-phenolics should be designed for .009 to .010 inches per inch. This difference of .002 inches is exhibited across the board on all the rubber-phenolic family. This is not completely borne out by a study of the data sheets. It is a result rather of experience which has been gained in the field over the last few years. This does not mean that the rubber-phenolics cannot be used in molds previously designed for other materials; but rather that the tolerances would be broader. Molds already in use on other materials have been successfully used on rubber-phenolics, but have been, by and large, jobs where dimensional tolerances were not too critical.

This brings up the question of dimensional tolerance. The tolerance chart which has been published by S.P.I. shows the tolerances which can be expected with conventional woodflour-filled phenolic in black and that of its rubber modified counterpart in red. Generally speaking, the tolerances that can be expected with the rubber-phenolics are plus or minus .001 inches greater than with the conventional phenolics. Perhaps some of you have had experience with the rubber-phenolics and say we can't hold those tolerances. But this data has been borne out by many jobs in a variety of molding shops, and we believe that they can be held. Remember that we are dealing with a new material, and some of the older handling and molding techniques might have to be modified to obtain these results. For example, since this material is quite rubbery as it is discharged from the mold, the necessity for shrink forms, weights, and the like, is far greater than with the conventional phenolics. More care must be exercised if the part is to be kept within minimum tolerances.

General Electric has advised larger knock-out pins and as many as practical in the design of molds for rubber-phenolics. Due to rubbery discharge, the chance for distortion is somewhat greater and therefore will require considerable design consideration in order to overcome this objection.

In the design of molds for rubber-phenolics, we would normally advise that an allowance of $^1/_2$ degree per side be used for draft. Naturally, undercuts and dead-end pockets should be avoided wherever possible, and this is particularly necessary for the successful molding of the rubber-phenolic materials, due to the vulcanizing system used which is necessary to cure the rubber portion. The rubber-phenolic materials are somewhat more gassy than their conventional counterparts and need, therefore, some means of getting rid of the excessive gas formed during the molding operation. It is generally recommended that bleeders at the parting line or flash vents be provided, and also that flash vents be provided along the knock-out pins, particularly those which tend to be in sections where gas

For Rubber-Phenolics . . .

might be trapped.

MOLD SURFACE IMPORTANT

The surface of the mold is quite important in the successful molding of rubber-phenolics. It is recommended that a good high polish mold be used, and it is certainly advisable to chrome plate. One word of caution; select one of the better chrome platers in your area to chrome plate the mold intended for molding rubber-phenolics. A spongy chrome job is no better than no chrome at all. If molded-in holes are to be considered, it is recommended that the pins making these holes be polished by draw polishing rather than by any polishing method which tends to leave scratches or marks at right angles to the axis of the pin. This is necessary to avoid any possibility of binding during the ejection of the part from the mold.

Warpage particularly plagues those who would successfully mold rubber-phenolic materials. What can be done to eliminate warpage? Here are a few tips which might be used to minimize the effect of warpage: Check pressure—reduce if possible. Check gates—relocate if indicated. Check closing speed—slow down. Check ejection. Relocate or enlarge knock-outs if indicated. Look for possible binding or cocking action. Check cure—increase cure if necessary. Check cooling fixture—provide if necessary. Remember that the rubber-phenolics are a rubbery material, particularly on discharge and therefore handling must be done with care. It is my belief that more warpage is occasioned by careless handling than by any other single factor. Very frequently, all that is required to keep warpage at a minimum is the placing of a proper sized weight on top of the molded part until it is sufficiently cooled to be satisfactorily handled. The rubber-phenolics have a very long duration of flow and are capable of exceedingly long draw applications. The use of reinforcing ribs is not as necessary as in the woodflour-filled standard phenolic materials. Should ribs be desirable, there is no problem in the design or molding of these ribs and bosses. Rubber-phenolic materials can be molded in any conventional type mold. In compression molding, it is advisable to stick to the positive or semi-positive type molds in order to obtain as much back pressure as possible. The design of transfer molds should follow conventional lines; however, the runner and gate design should be carefully located to insure even filling of the cavity.

MOLDING METHODS

Let's review briefly the general molding methods used for the rubber-phenolic materials. We would suggest a minimum temperature of 300°F and a maximum of 350°F for molding temperature. Generally, the best operating range would be 310-330°F. Field experience has shown this range will give parts with better appearance and less staining. In compression molding, it is suggested that 1 to 3 tons per square inch based on projected area would be the operating range and 2.5 to 4.5 tons per square inch for transfer or plunger molding, based on pot area. It is suggested that the molder use the minimum pressure required to obtain a dense satisfactory part since the rubber-phenolics, like some thermoplastics, have some tendency to pack due to their resilient nature. Overpressure and the resultant packing may cause excessive staining and stick-

FIGURE I.

A COMPARSION OF THE PROPERTIES OF RUBBER-PHENOLICS AND CONVENTIONAL PHENOLIC.

CONVENTIONAL PHENOLIC VS. RUBBER PHENOLIC (WOODFLOUR FILLED)

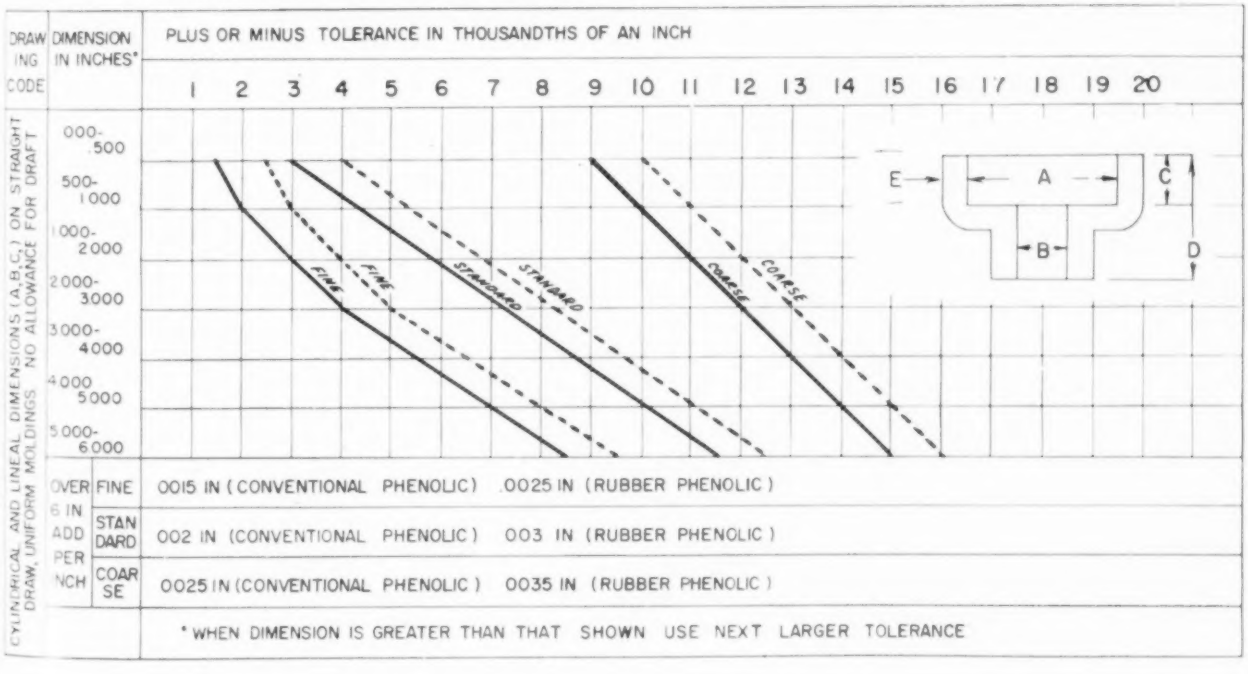


Figure 2. Impeller and silverware basket for an automatic dishwasher.

Figure 3. X-Ray timer housing, a motor sheave and an autoclave hand-wheel.

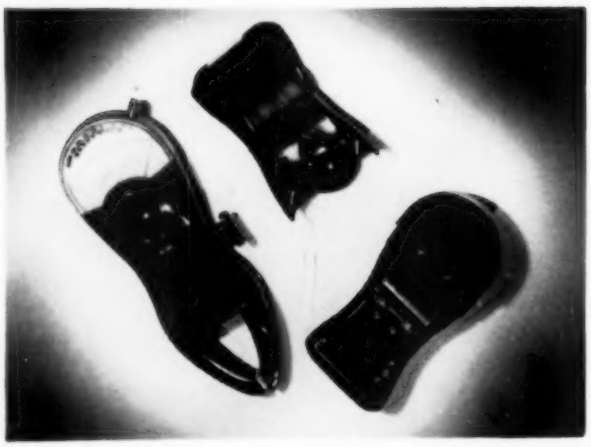


Figure 4. This clamp type voltmeter housing is molded in a combination type mold.

ing, as well as warpage and dimensional instability. This is noticeable particularly on transfer jobs where spring-back of parts molded under excessive pressure will cause distortion after removal from the mold.

A uniform slow rate of transfer into the cavity at minimum pressure would be considered ideal for transfer molding. This would permit a ready escape of gas and would tend to minimize the packing effect. Slow closing is also recommended on compression molding, and certainly gassing or breathing is advisable wherever the design of the part indicates. Preheating, as in the standard phenolics, helps to reduce the cure time and it is recommended that electronic preheating be used with a longer preheat at lower amperage, giving the best results by providing long duration of flow and helping to remove gas. It is our opinion that optimum preform temperature is in the neighborhood of 280°F, which is just below the smoking point.

AUTOMATIC DISHWASHER

Figure 2 shows an impeller for an automatic dishwasher and also the silverware basket for an automatic dishwasher. The impeller is made in a single cavity, landed plunger mold and is normally run at approximately 20 tons total pressure. Mold temperature in this case is 340°F, and with electronic preheat could be cured in 3 minutes. In order to remove gas from some of the dead pockets, it was found necessary to turn the mold upside down and employ a gassing cycle. The rubber-phenolic impeller has replaced an impeller of the conventional phenolic type which had been subject to considerable breakage when silverware was inadvertently dropped onto the blades of the impeller. Replacement costs were excessive, and field complaints numerous. The asbestos-filled rubber-phenolic impeller was tested by dropping a weight through a pipe onto the edge of the blade. The result showed that the rubber-phenolic impeller withstood the dropping of the weight from a height at least 5 times greater than did the conventional impeller. The extended exposure of the rubber-phenolic impeller to hot water and detergents in actual operation has shown no significant loss of strength. The silverware basket is molded from the wood flour filled rubber-phenolic material. This is also a semi-positive mold, three cavities, and molded at 65 tons pressure. Mold temperature is 330 on the force and 350 on the cavity. This part is molded without a gas cycle and is molded with an over-all cycle of 2 minutes. The silverware basket had been previously made from brass screen and costs ran high because of bending in shipment and assembly. There were also a considerable number of customer complaints due to the scratching of valuable silverware. Again, tests have shown that neither hot water nor detergents nor the combination of both cause failure of the rubber-phenolic dishwasher basket. Complains have been reduced to a minimum.

TIMER HOUSING

Figure 3 shows an x-ray timer housing, a motor sheave and an autoclave hand wheel. The timer is transfer molded in a 350 ton press and is a two cavity composite mold, one back and one front being molded simultaneously. The mold temperature is 330° in all portions of the mold. The gate dimension is a 5/16" semi-round gate and the length of runner is 3½". Pills are preheated dielectrically for 60 seconds to a pill temperature of approximately 250°F. Plunger speed is 12 seconds to close, and the part requires a 3 minute cure time. Due to the excellent finish on the mold, the gloss of the finished part is very good. A rubber-phenolic material has been required since the timer is subject to being dropped and otherwise abused.

The motor sheave was formerly machined from low carbon (.2%) carburizing steel. This part is used as the

drive pulley on a generator test bench. The part is made from the flock-filled rubber-phenolic material. It is molded in a single cavity landed plunger split compression mold, and the mold is vented at the bottom across the split. The mold, in this case, was designed to a shrinkage of .015" per inch and is reported to give the dimensions required. The part is molded in a 100 ton press reduced to 50-60 tons. The mold temperature is 310°F on the plunger and 320°F on the cavity. The material is powder loaded and preheated for 5 minutes under infrared lamps. The cure time is 3½ minutes, comparing with 3¼ minutes for conventional phenolics under the same conditions. A shrink plug is used on the bore to reduce warpage. The part is held to a concentricity of plus or minus .005" on the outside edge of the V groove. This part is 4 inches in diameter by 2 inches thick and contains three different sized grooves to accommodate different shape pulley belts. Two 10-24 holes are tapped, and the 3/16" key way is molded in. These parts in machined steel had to be held to a concentricity of plus or minus .001" to avoid bad vibration. The rubber-phenolics can run up to plus or minus .010" on concentricity before bad vibration is noticed. The cost of the rubber-phenolic sheave is only 37c, compared to a cost of $2.12 for the machined steel. Better performance is obtained due to more uniform density and not as much vibration from centrifugal force due to lower mass. A test cycle consists of: turn on motor, run up to full speed, and turn off. The rubber-phenolics ran 13¼ hours or 2,430 cycles driven by a 1½ H.P. motor with no sign of wear.

AUTOCLAVE HAND WHEEL

The autoclave hand wheel was molded from the woodflour-filled rubber-phenolic in a single cavity transfer mold at 70 tons pressure. Based on a 5"x3" pot, this is 4.6 tons sq. in. It was found that higher pressure gave cracking. The design of the mold is such that the material sprues directly into the part at three places. The mold temperature is 340°F in all portions of the mold, and three pills approximately 2½" x 5" x 1" are dielectrically preheated. A cure of 5-6 minutes is obtained. It is interesting to note that the insert weighs 2½ pounds and is 3½" in diameter. There is only ¼" of material anchoring the insert, and there is no metal in the spokes or rim of the wheel. The insert is placed in the mold cold. Only with the rubber-phenolics can such a molding procedure be used without excessive cracking. The use of the rubber-phenolic material has reduced the rejections by 80% and results in a wheel with better finish than with the rag stock formerly used.

VOLTMETER

The clamp type voltmeter housing (Figure 4) is molded in another combination type mold. The front and back are molded in a two cavity transfer mold in a 10 inch ram press at 2800 pounds line pressure. The pot diameter is 6 inches and gives, therefore, 3.8 tons per sq. in. molding pressure based on pot area. The gate dimension is ⅛" diameter and sprues directly into the part. The mold temperature is 330-340°F in all parts of the mold. A charge of 660 gs. in the form of two pills are preheated in a 1.5 K.W. Thermall preheater for 28 seconds at 430 milliamps. to a temperature of 270°F. The mold closes in approximately 1 second and cures in 3 minutes. The part, on extraction from the mold, is immediately clamped in a shrink form and cooled in water. The two halves mate perfectly to give a snug fitting assembly. Since this portable test instrument is carried in repair kits, the housing must protect the instrument from careless handling. It must be light, rugged and have good appearance. General purpose materials proved inadequate strength-wise, and the conventional flock-filled material did not provide a sufficiently rugged housing even though appearance was sacrificed. The woodflour-filled rubber-phenolic material met all the requirements of the job and enabled the molder to obtain a satisfactory part without costly redesign and tool changes.

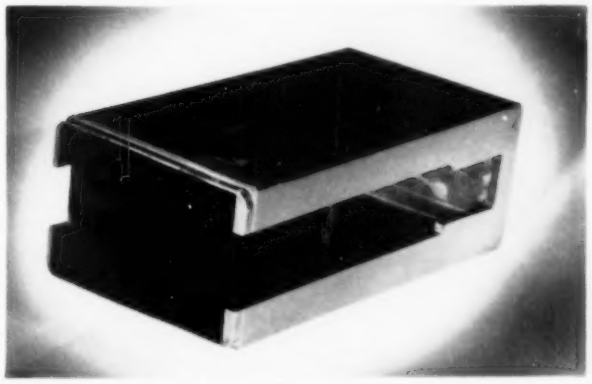


Figure 5. This transformer can is one of the larger pieces being molded from woodflour-filled rubber-phenolic.

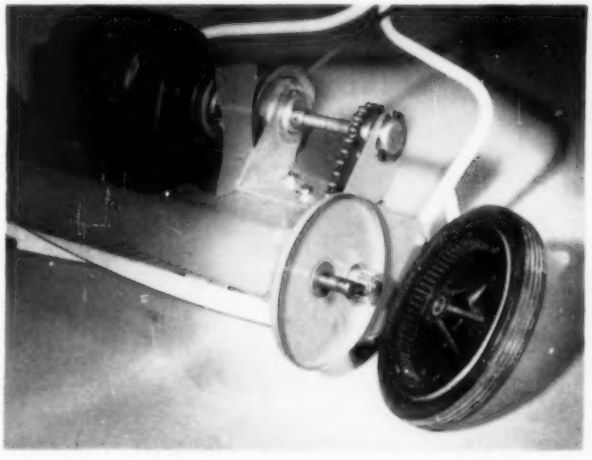


Figure 6. Lawn-mower wheels, molded in a single cavity semi-positive mold.

One of the larger rubber-phenolic parts being molded currently is shown in Figure 5. This part is a transformer can molded from the woodflour-filled rubber-phenolic material. The mold was designed for rag stock, but due to the extremely long draw, the molder was unable to obtain filled-out parts. The other conventional phenolics had insufficient strength for the application. Since the center line of the plunger must be held within plus or minus .015", the back up plate of the mold is three times normal thickness to prevent plunger shifting. The mold is a single cavity positive mold with a stripper plate for ejection of the part. The part is molded at 250 tons, and with dielectric preheat is cured in 4 minutes. The part dimensions are held to a tolerance of plus or minus 1/32". The rubber-phenolic can replaces an assembly consisting of a laminated part as well as an intricate post-formed riveted assembly.

LAWN MOWER

Here is a very unusual application — lawn mower wheels (Figure 6). This wheel is being molded experimentally in a single cavity semi-positive compression mold. The mold is in a 300 ton press reduced to 150 tons for this job. Mold temperature is 340°F and a charge of approximately 660 gs. in pill form is dielectrically preheated in

(Please turn to page 42)

Gregory J. Azarian

mold castings

Gregory J. Azarian
American Brake Shoe Co.

Presented at the Ninth SPE Conference

This article describes close-tolerance plain and alloyed iron castings now being applied to various phases of the plastics industry. Although iron molds and hobbing dies have been used during the past six years for the injection molding and hot hobbing of various types of plastics they did not make an impressive showing until approximately two years ago. Prior to that time, most of the precision type castings furnished to the plastics industry were being used as cores and cavities for dolls. In a few isolated cases, iron castings were used as dies for the hot hobbing of beryllium copper. However, since very few people were familiar with the properties of the as-cast or heat-treated iron materials they were somewhat hesitant to try the iron hobbing dies and molds; particularly with the feeling that iron would make a successful operation dubious. Many years ago an iron casting was merely a coarse grained material made by melting down old engine blocks, sewing machine parts and the like and upon fracturing showed severe cases of massive flaked graphite which certainly would not allow a polish suitable for plastic requirements. Since that time great strides have been taken in the iron industry.

THE FOUNDRY PROCESS connected with the production of close tolerance castings is very similar to an actual commercial foundry technique in that pattern equipment of a similar type is required. Patterns can be made of wood, plastic, plaster, or metal, whichever is most accessible. Naturally there are shrink rules which have to be incorporated in the pattern equipment and various other regulations which must be adhered to in order to facilitate molding of the patterns in such a manner as to result in the most finely finished and sound cast parts as is possible. A majority of the present users of iron molds and dies supply plaster patterns. Some of them go so far as to furnish finely finished metal patterns and a few supply pattern equipment in wood. However, generally speaking, most of our pattern equipment is of the plaster type; in other words, it may be hydrocal, tamistone, dental plaster or combinations of the above. Of major importance is the fact that the degree of smoothness and fine detail in the pattern equipment definitely controls the resultant degree of smoothness and finish on the final castings. This is important to the operators of mold and die shops since the degree of smoothness of a precision casting determines the amount of bench working or fancy polishing of the hobbing dies or molds themselves, after receipt by the customer.

TYPES OF FERROUS MATERIALS

At the present time there are three types of ferrous materials being used for plastic mold and hob castings. These materials are a fine grade unalloyed iron, a fine grained alloyed iron, and in some cases high carbon-high chrome metal. All three metals polish to a good luster for most plastics applications. This fine luster is made possible through use of electric furnace melting and high steel scrap remelt. It is generally accepted that steel scrap contributes appreciably to the degree of fineness of iron castings.

Recently, when it was so difficult to obtain ferro-alloys for plastic mold applications we found that a fine grained unalloyed iron was accepted by the industry. However, because of its fairly low strength it was not able to withstand the abuse which an alloyed iron material could withstand in some applications. In the plastic application we designate an alloyed iron as one which has approximately 1½% nickel, ½% chromium and ½% molybdenum. This ratio of alloy to iron is low, but it is sufficient to add appreciably to the physical properties of the molds and dies. It was determined in some applications where extensive pressures were required to reproduce detail in hobbing dies, that the unalloyed iron molds were unable to withstand these pressures, whereas the alloyed iron dies were satisfactory. However, in most novelty plastic applications the unalloyed iron material was found suitable and definitely resulted in a fast and economical mold source for the various shops which had and still have been demanding molds yesterday. At this writing, although the alloy situation is somewhat relieved, most of our mold and hobbing die shops still use the non-alloyed material.

The National Production Authority requires foundries using ferro alloys in castings to obtain metal approval before these alloys can be used. Since there is a six or seven week delay in obtaining this approval and since no efficient shop can tolerate this delay, we still find a great demand for the non-alloyed iron. Lately however, several of the shops have been submitting blanket orders to protect their alloy allotments for periods of three or four months at a time and, by such a method they can still submit pattern equipment to the foundry and receive castings, in most cases, within two weeks after submitting this equipment.

A third material being used for plastics molds is the high carbon-high chrome analysis. High carbon-high chrome is a somewhat more difficult metal to pour than either the plain or the alloyed iron. It is a high melting point iron and requires special care in handling, particularly in the molten state. In specific applications we are successfully using high carbon-high chrome material; this will be mentioned later in the discussion.

HEAT TREATMENT

During the past several years we have undertaken various types of heat treating procedures on our iron hobbing dies and complete molds. We have supplied castings in the as-cast condition, fully or partially hardened, and in a fully annealed state; fully annealed material has a Brinell hardness of 22 to 26. Through past experience and extensive tests we have determined that the fully annealed castings are received most readily by the customer; castings in this condition are easily machined and because of their characteristic iron properties still have a good resistance to deformation and upsetting even in the low Brinell hardness range of 22 to 26. Since all castings are annealed in a neutral atmosphere furnace or packed in various types of compounds which will prevent decarbonization there is no opportunity for the die or cavity to lose carbon resulting in a softer and inferior working surface.

There are various branches of the plastics industry for which ferrous molds have been and are now being successfully used. Initially, there was a considerable number of hobbing dies and core and cavity molds furnished to the novelty trade. Here the emphasis is on a good polish and a good match. Dimensional tolerances in most cases are secondary and although ferrous castings can be held closely dimension- wise it is not necessarily a prime requisite. Many of the people who produce doll cavities use iron molds for actual cores and cavities. There are others who use iron molds for hobbing dies from which are produced pressure casts of beryllium-copper dies. Many of you will wonder why some people use iron for cores and cavities and others prefer non-ferrous metal. In answering, it can be stated that both materials are good; and the decision is up to the individual in most cases. The results indicate that good iron can resist considerable abuse and at the same time, with some degree of care, will more than pay for itself through the number of molded parts it produces before finally being discarded.

DEVELOPMENT WORK

In the recent past there has been a great deal of development work done in the plastic line in applications such as plastic pipe fittings. In one instance these fittings were to be used on non-magnetic mine sweepers. In these applications where the surface finish of the parts is not critical and where people desire something that is somewhat better than the plain or alloyed iron, we have been able to supply a high carbon-high chrome material which can be annealed or softened, is easily machinable, but which is easily hardened to a Rockwell of 55 to 60.

Recently there has been a great deal of work done on the low pressure molding of fiberglass, laminated or other types. Here again, in many cases, an extremely critical dimensional control is not necessary. We have found in our work that so long as a person is in a position to match the force to the cavity of the mold properly with a consistent and desired spacing between the force and the cavity there can be considerable elasticity in all other length and width dimensions. The unalloyed fine grain iron has proven satisfactory in this work and as a result the future will see a decided increase in the production use of low pressure fiberglas iron molds.

MOLD FINISHING

I would like to caution you in one respect concerning fiberglas molds. In many applications people are misled by the word precision. We have found that in several cases, molds have been supplied full rather than to exact dimensions; in other words, have been supplied with a finished stock of .010" to .015" over and above that which is required for polishing; the customer in turn has taken these molds, and, although he has had to bench work the castings, has been able to avoid the fancy cutting and engraving of the dies. In other cases where the molds were of a considerable size, say in the vicinity of 1,000 to 2,000 pounds, as castings, we have found that we can supply a precision cast cavity and a commercial cast force. A commercial cast force in our language is one which would have anywhere from 1/8 to 3/16 inch of finished stock on all surfaces. "Well, where is the advantage here?" The advantage is that the cavity can be polished without difficulty; again the operator can avoid the expensive engraving of a difficult half of the mold. Into this polished cavity can be poured plaster material to produce a master for the operator's duplicating machine; then through intelligent use of this master the full force can be cut with no difficulty and also with assurance that when completed it will satisfactorily match the cavity casting.

ADVANTAGES OF IRON MOLDS

There are several advantages that people can enjoy through the use of precision cast dies, and cores and cavities which cannot otherwise be enjoyed by other methods. Initially, there is price; although the iron castings are not always as low in cost as some users would like to see them, the end cost of molds shows definite savings in both time and money. They are an attractive source of castings in the finished state and this can be definitely proven through discussion with various users of the iron parts at the present time. Next, and probably even more important than the price, is delivery. When operations are performing smoothly and functioning in a normal set-up rather than in the present inflated set-up where defense commands a top priority, iron castings can be delivered to the customer within 10 days after receipt of that customer's pattern equipment in the shop. Although this 10 days is extended to 2 to 3 weeks at the present time it is our hope that within the next few months we will again be in a position to revert to the 10 days. It is realized that the plastics industry is a highly competitive type of business, the people want their molds, they do not want expensive molds, and they want them fast. This certainly can be appreciated and efforts are always being made to improve on the delivery times for close tolerance iron molds.

There is another advantage to the use of precision iron castings in the plastics industry; in applications where a person desires a considerable number of castings of the same type, he is required to submit only one pattern. From this pattern it is possible to furnish as many castings as the customer wishes. Of course, since he has required the use of a master or a model to produce the pattern which the iron shop uses; should the first pattern wear or should he wish several castings at one time and in a shorter time, it is always possible to supply more than one pattern. In comparison, in the case of tooled parts, where damaged molds cannot be salvaged it is necessary to start from scratch. Castings can be obtained in a much shorter time where patterns are available.

MOLD REPAIR

"What can be done to the iron molds should they be chipped or nicked, or cracked?" Some of our people suc-

(Please turn to page 42)

Dr. Lawrence E. Nielsen & Dr. Rolf Buchdahl

Dynamic ... of

L. E. Nielsen and Rolf Buchdahl
Plastics Division
Monsanto Chemical Company

Many types of mechanical tests are used for the evaluation of plastic materials. Most of the tests have been devised to learn something about a very specific property of a limited class of materials. Furthermore, many of these tests give arbitrary numerical values that are dependent upon the kind of instrument used. Such tests may be useful, but they certainly are not the most desirable type. A general test based on sound scientific principles has the possibility of disclosing much more information about the mechanical properties and structure of a material than most of the tests now being used. Certain dynamic mechanical tests fulfill the required conditions.

IN DYNAMIC MECHANICAL tests, an oscillation or a mechanical vibration is set up in the test specimen. By measuring the response or deformation of the plastic material when subjected to periodic forces, it is possible to calculate an elastic modulus or stiffness and mechanical damping or energy dissipation factor for the test material.

Perfectly elastic materials nearly instantly deform by an amount proportional to the applied force. The work done in bringing about the deformation is stored and is completely recoverable again when the force is removed. This is like stretching and unstretching a good spring. A weak spring, which is easily stretched, would correspond to a low modulus material such as rubber. A stiff spring would correspond to a high modulus material such as polystyrene or rigid phenolic plastics. Elastic moduli are usually expressed in pounds per square inch or dynes per square centimeter. (1 lb sq. in.$=7\times10^4$ dynes cm^{-2}.) A typical rubber has a shear modulus of about 100 pounds per square inch while rigid plastics have shear moduli of about 100,000 PSI or greater.

Plastics, however, do not behave like perfect springs, so when they are deformed, not all the work done on deforming them is stored as potential energy and again recoverable when the applied force is removed. Part of the work of deforming the plastic goes into the generation of heat. It is this dissipation of energy into heat that brings about mechanical damping. As will be pointed out later, damping manifests itself in various ways. For instance, polystyrene is a low damping plastic and gives off a ringing sound when struck. On the other hand, most cellulosic plastics have relatively high damping and sound very "dead" when struck. A good rubber band has a lot of "snap"; it has low damping. Soft plasticized polyvinyl chloride has a leathery feel; it is a high damping material.

Many instruments have been described for measuring dynamic mechanical properties. Some of these instruments measure the shear modulus, some Young's modulus, and some the bulk modulus. Some of them were designed for soft rubbery materials and others for rigid plastics. In most instruments the period force changes in a sinusoidal manner. Experiments have been described in which the force (and therefore the deformation also) has varied from a rate of a fraction of a cycle a second up to several million cycles per second. It is readily apparent that dynamic testing is a large field and that no single instrument is capable of measuring all types of materials and moduli over a wide frequency range. In addition, with plastic materials it is especially important to make tests over a temperature range.

In the interest of economy and, at the same time to get as much useful information as possible, it seems desirable to use an instrument with the following characteristics:

1. Will measure the shear modulus of all materials from rubber to rigid plastics.
2. Capable of measuring both low and high damping materials with any value of modulus.
3. Only one or two small specimens of convenient size and shape required for complete tests.
4. Temperature control from very low to very high temperature (say −65°C to 200°C).
5. An approximately constant frequency of deformation of the order of 1 cycle second.
6. The method of making the test and the calculations should be simple.

A torsion pendulum seems to best fulfill these conditions. The principle of the torsion pendulum is illustrated in Figure 1. One end of a plastic strip or rod is rigidly clamped, while a moment of inertia disk is attached to the other end. The specimen and moment of inertia disk can be set in oscillation by giving the disk a twist and releasing. As the system oscillates, the plastic specimen will

Mechancial Properties Plastic Materials . . .

be twisted and untwisted. Due to damping, each angle of twist will be less than the preceding one. Thus, the damping is calculated from the rate of dying down of the oscillations. The dynamic shear modulus is calculated from the frequency of the oscillations. With the same moment of inertia disk and the same specimen size, a rigid plastic will give a higher frequency of oscillation than a rubber. Figure 2 shows how the angle of twist changes with time for several materials.

The shear modulus—G in pounds per square inch—is calculated by the following equation for specimens of rectangular cross section:

$$G = \frac{5.588 \times 10^{-4} LI}{CD^3 \mu} \cdot \frac{1}{P^2}$$

where C = width of the specimen (in inches)
D = thickness of specimen (in inches)
L = length of specimen (span between clamps) (in inches)
I = moment of inertia (in g cm²)
μ = a shape factor based on ratio of width to thickness of specimen. See Table I for typical values.
P = period of oscillation (in seconds). The period is the time for one complete oscillation as shown in Figure 3.

The shear modulus in pounds per square inch for specimens of circular cross section is given by

$$G = \frac{3.59 \times 10^{-4} LI}{R^4} \cdot \frac{1}{P^2}$$

where R is the radius in inches.

The damping can be determined by calculating the logarithmic decrement δ. This quality is the logarithm (to a base e) of the ratio of the amplitudes of two successive vibrations. From Figure 3,

$$\delta = \ln \frac{A_1}{A_2} = \ln \frac{A_2}{A_3}, \text{ etc.}$$

In actual practice, these calculations can be greatly simplified by the use of three types of charts—one type for high damping materials, one for moderate damping materials, and one for low damping plastics.

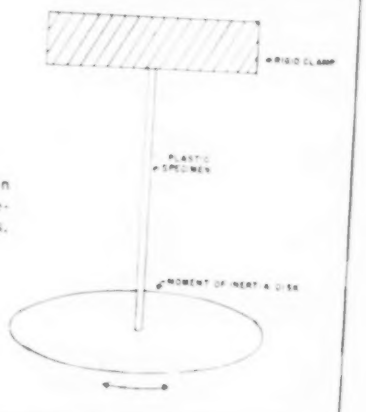


Figure 1. The torsion pendulum for measurement of shear modulus.

TABLE I

Ratio of Specimen Width to Thickness	Shape Factor μ
1.00	2.249
1.20	2.658
1.40	2.990
1.60	3.250
1.80	3.479
2.00	3.659
2.25	3.842
2.50	3.990
2.75	4.111
3.00	4.213
3.50	4.373
4.00	4.493
4.50	4.586
5.00	4.662
6.00	4.773
7.00	4.853
8.00	4.913
10.00	4.997
20.00	5.165
50.00	5.266
100.00	5.300

FIG. 2

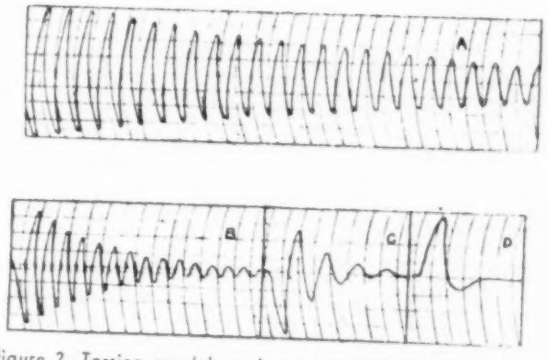


Figure 2. Torsion pendulum chart, showing how angle of twist varies with time for different materials. These are typical damped oscillations. A. Low damping rigid plastic. B. Moderately damped material. C. Highly damped material.

FIG. 3

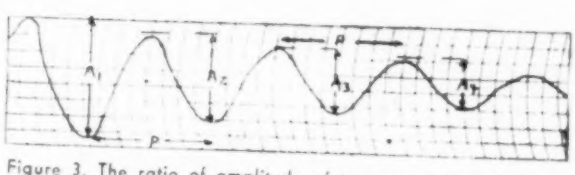


Figure 3. The ratio of amplitude of two successive vibrations is used to calculate the damping of the torsion pendulum. "A" is the amplitude of the vibration, and "P" is the period of the oscillation.

FIG. 4

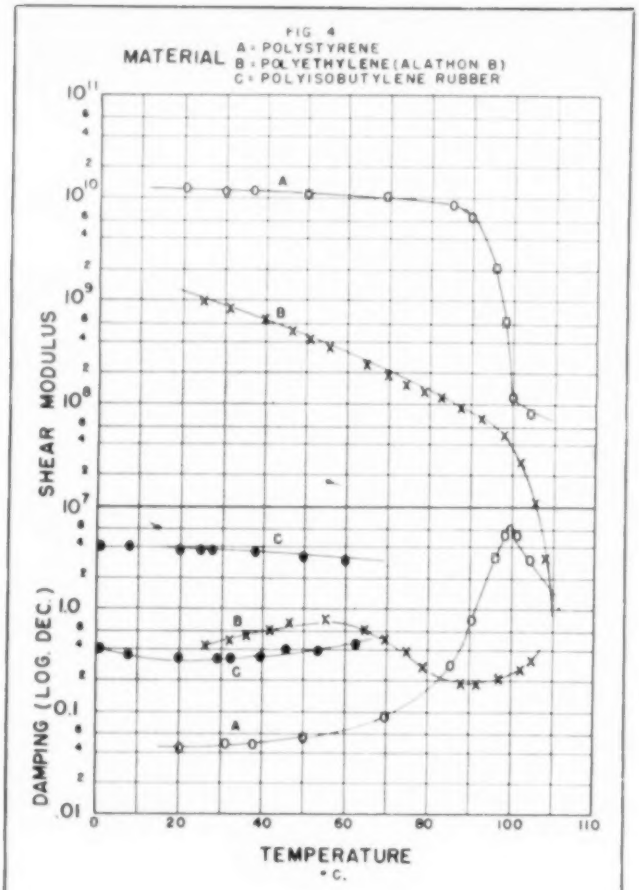
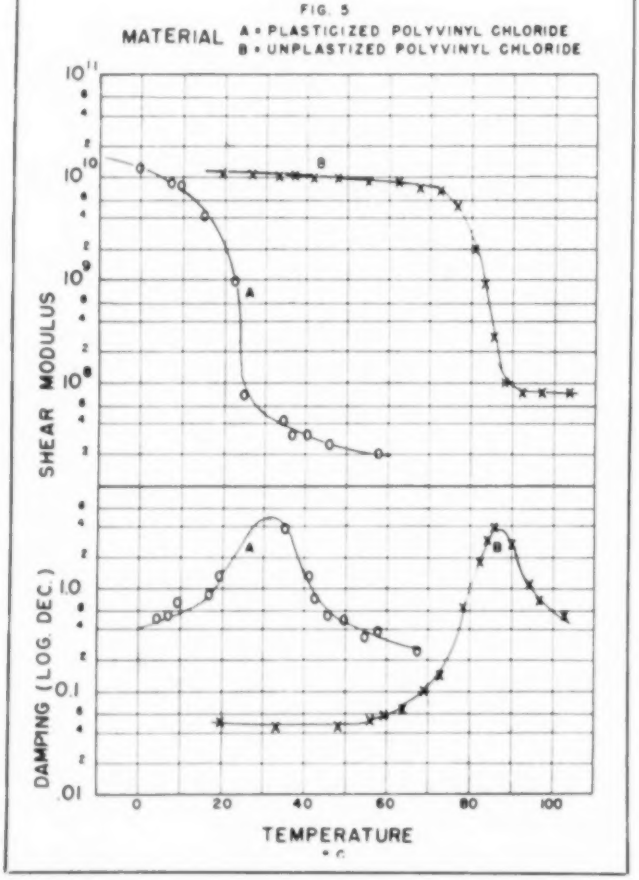


FIG. 5

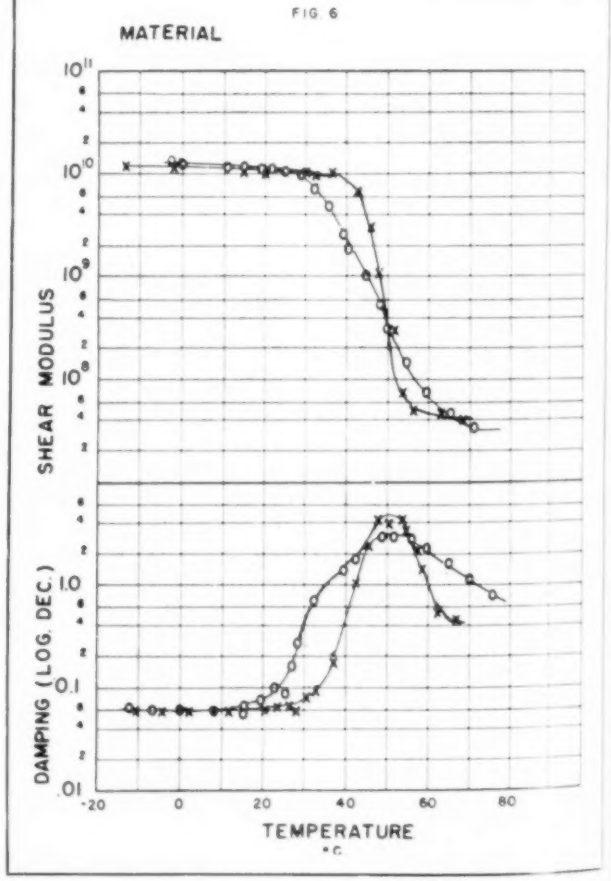


Most non-crystalline (or slightly crystalline) thermoplastic materials have dynamic mechanical properties similar to the polystyrene curves labeled A in Figure 4. At low temperatures the plastic is rigid and has a high modulus or stiffness. As the temperature is raised, the material goes through a transition region where the modulus rapidly decreases by a factor of several hundred or a thousand times. At still higher temperatures the modulus again remains relatively constant but low; the material now behaves as a rubber.

Below the transition temperature where the modulus is high, the damping is usually quite small. As the temperature is raised through the transition region, the damping becomes very large and goes through a distinct maximum. In the transition region the high damping makes the material have a dead, leathery feel. At higher temperatures the damping again increases. For crosslinked rubbery materials the damping will remain small over a wide temperature range. However, for uncrosslinked rubbers such as polyisobutylene or polystyrene above 110°C, the damping goes through a minimum and again increases quite rapidly at the higher temperatures where viscous flow becomes important.

The modulus and damping curves over a temperature range tell much about a given material. The damping peak occurs in the softening range of the plastic. Sharp damping peaks indicate a narrow softening range. The ASTM heat distortion temperature occurs where the modulus curve starts to drop off and the damping curve begins to increase towards its peak. The second order transition temperature is generally found at about the same temperature. Thus, the damping peak defines the region in which the molecules are becoming free to move

FIG. 6



readily and are no longer frozen into fixed positions as they do at lower temperatures.

Even at temperatures well below the damping peak, plastics differ much in the value of the damping. It is generally true that very low damping materials such as polystyrene are brittle, have low impact strength, and have small elongations before breaking. On the other hand, materials with much larger damping, such as most cellulosic materials, have high impact strength and tend to show yield values and high elongations in a stress-strain test. As might be expected, dimensional stability and creep effects are related to mechanical damping. Materials with a high damping show a high creep rate. The modulus determines the amount of creep or deformation at short times, but the damping determines how the deformation at constant load will change with time.

Figure 4 shows the dynamic behavior of three typical thermoplastic materials — polystyrene, polyethylene and polyisobutylene. The damping peak is in the neighborhood of 110 C for polystyrene and would be about -40 C for polyisobutylene. Polyethylene shows a behavior very different from the other two materials. This is because of the crystalline nature of polyethylene. Polyethylene would be a rubber or viscous liquid like polyisobutylene if it were not for its crystallinity. Polystyrene is rigid at room temperature because it is below its second-order transition temperature; polyethylene is rigid because it is below its first-order transition temperature.

Figure 5 shows how the dynamic properties of polyvinyl chloride are changed by the addition of a plasticizer. Plasticizers shift the damping peak to lower temperatures and at the same time broaden the peak. This is typical of plasticizers and solvents for all plastics which can be plasticized. The amount of shift of the temperature of maximum damping is a linear function of the volume of added plasticizer as long as the plasticizer tends to be soluble in the polymer.

Copolymerization shows many of the characteristics of plasticization. The lower "melting" component of the copolymer lowers the softening temperature of the higher "melting" component. The width of the damping peak can be used to determine the degree of chemical heterogeneity in copolymer molecules. In homogeneous copolymers containing equal molar quantities of comonomers A and B, all molecules would have the composition -ABABAB-. Heterogeneous copolymers of the same total composition might have some molecules such as -AABAAB- and some such as -ABBABB-, etc. Such differences in structure readily show up in dynamic tests as shown in Figure 6 for two vinyl chloride-methyl acrylate copolymers of different degrees of heterogeneity. The damping peak becomes broader and does not reach such a high maximum as the heterogeneity increases.

Thermosetting materials may also be investigated by dynamic tests. The damping is especially sensitive to fillers and degree of cure. Figure 7 shows the difference between a slightly cured and a highly cured phenol-formaldehyde resin. The damping peak characteristic of thermosetting plastics and slightly cured resins seems to have disappeared for highly crosslinked materials.

Dynamic mechanical studies above the second-order (or glass) transition point can be carried out with a torsion-pendulum type apparatus provided the modulus does not become too small—lower limit about 10^5 dynes/cm^2. Rather striking differences can be observed by this method and a few examples are shown. See Figure 8. In the case of polystyrene, for example, the damping first goes through a minimum and then increases rather quickly with

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FIG 7

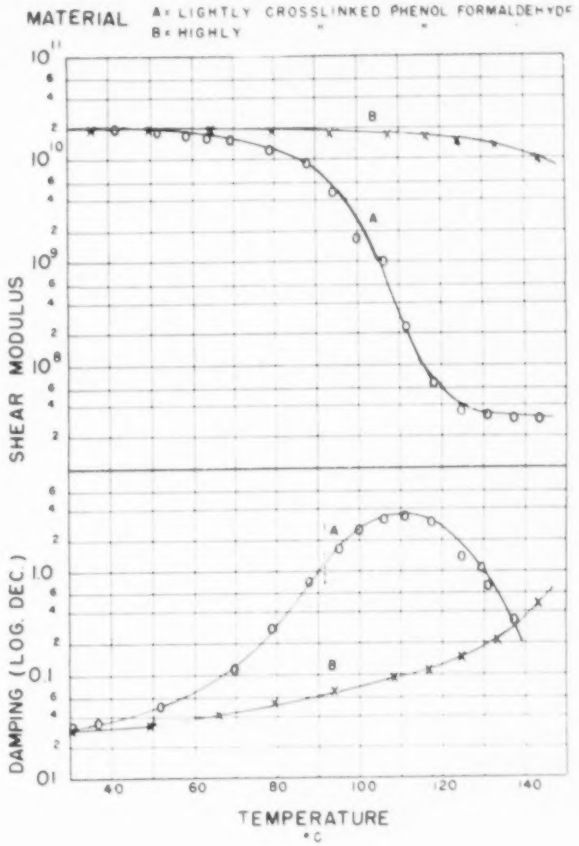
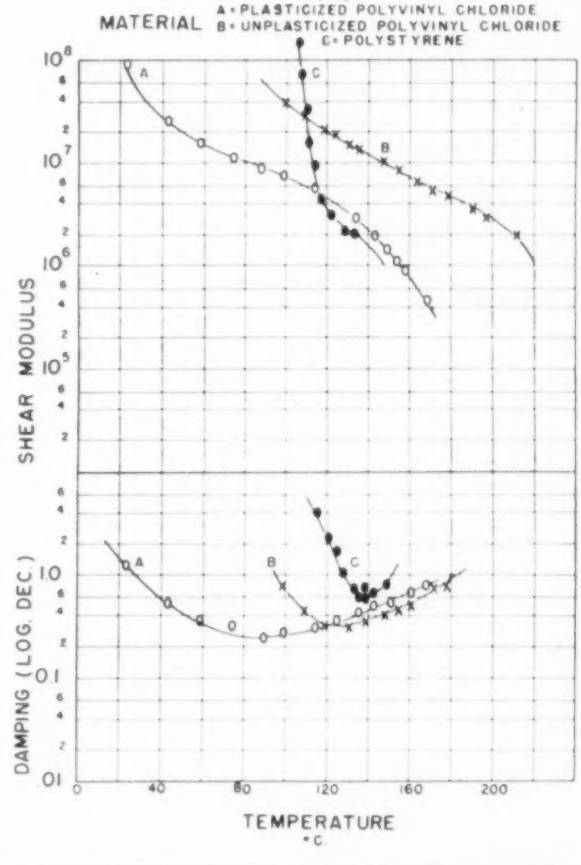


FIG 8



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NDC TRADE MARK

Biaxially Oriented Methacrylate and Polystyrene Sheet

C. Paul Fortner

C. Paul Fortner
Plax Corporation

Presented at the Ninth SPE Conference

Orientation of plastics, especially that of various plastic filaments, has been widely discussed. There have been some recent papers on biaxially oriented sheet.

There are several conceptions of what orientation by stretching does to the molecules. The most widely accepted is the idea that the completely random organization of the elongated molecules is changed so that the long axes are more inclined parallel to the directions of stretch. Other conceptions are related to the probability of changing the actual physical shape of the molecules, rather than just their position. This latter more easily explains the relaxing to original shape when an oriented piece is slowly heated with no stress, and the partial loss of orientation when an oriented piece is held immobile and heated above the original orientation temperature.

IF A FILAMENT or sheet of plastic is stretched in one direction under temperature conditions such that the molecules can move somewhat, but are still not free to move as in a fluid state, they tend to change in such a manner that if the plastic is cooled in that condition the physical properties will be considerably altered. If, however, a sheet is stretched in two directions at once, or if first in one direction and, while held in that condition, is stretched in a transverse direction, still different properties result.

At the Plax Corporation, these changes in physical properties have led us to develop experimental equipment for the production of biaxially oriented sheet. As with most development of such equipment, the early machine was relatively simple compared to later equipment.

Attempts to produce continuously and of reproducable quality indicated the necessity of more temperature controls, more speed adjustments and sturdier machine parts for newer machines.

It is interesting, I believe, to note that temperatures are indicated or recorded at 59 places and provision is made for control at all these points either manually by the operator or by control instruments, as well as at 5 places where measurement is not considered necessary.

Speed in feet per minute or RPM is indicated at 7 points and is adjustable at 9 places.

Plastic pressure is indicated at 2 points and equipment to measure tension in the sheet is being developed.

Nine cam adjustments can be made in the effort to adapt the stretch pattern to the peculiarities of the powder being run or to produce a sheet with particular properties.

The above indicates to some extent the degree of control necessary to compensate for variations in molding powder and to run various gauges. There are additional mechanical changes made before starting a machine, if major gauge changes are contemplated. Our present range of commercial gauges is .003" to .020", although some thinner materials have been produced.

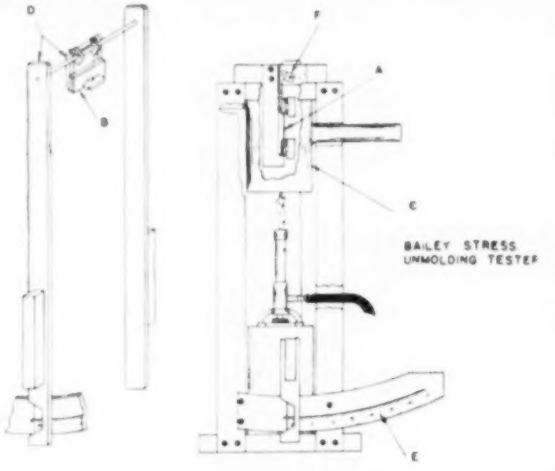
To elaborate somewhat on the reason for the many temperature control points requires consideration of the fact that the stretch, to accomplish its object, must be done within a narrow temperature band. If the sheet is too cool, little stretching can occur, and sheet tearing results. If too hot, thermal relaxation will remove the effects of orientation.

UNIFORM COOLING

The sheet must be handled and cooled in such a manner that it is not deformed, but is cooled uniformly to stretching temperature. Edge effects of radiation, machine radiation and transient drafts make this somewhat difficult. If there are gauge variations, they affect cooling rate and, consequently, whether or not the sheet breaks or retains its orientation. Hot or cool spots in the equipment have the same effects and may, therefore, be introduced to modify gauge where other corrective measure are difficult.

To determine if all these variables have been properly

Figure 1. A diagram of the Bailey stress unmolding tester, for determining stress and temperature at which a molded sample deforms.



controlled, several tests have been developed. Gauge, besides being measured with micrometers, is continuously indicated and recorded with a Beta ray gauge. Samples are periodically unmolded, as discussed in Mr. Bailey's paper before this group at Detroit, in 1948. Samples are also periodically unmolded by heating progressively in an oil bath with provision that the stress at unmolding temperature can be measured. This equipment, built by Mr. Bailey, is illustrated in Figure 1. As can be seen, the sample (A) to be measured, is held in clamps (B) and immersed in an oil bath (C). The temperature of this is increased slowly. As unmolding temperatures are reached the sample tends to relax and shrink. The force to prevent this is supplied and indicated through the linkage (D) on the scale (E). The bell crank arm (F) was made very short to make the inaccuracy due to actual shortening of the sample (A) a minimum.

A plot of the temperature versus stress shows that as temperature increases the stress rises to a maximum and then drops off (Figure 2). This maximum stress is used as that which was imparted to the sheet at that temperature in the machine. If this stress is too low, the sheet is brittle.

A plot of stress versus time at various temperatures of the bath is interesting. This shows that a slowly rising temperature of the bath will more quickly and accurately indicate maximum stress than a set temperature versus time test. It is also possible to show differences in polymers by this method. Figure 3 illustrates two lots of similar polymers run under similar machine conditions, but with sufficiently different results that one made good sheet and the other questionable.

For normal sheet usage, it is desirable that the stress be about the same in both directions. Some special uses, however, require extreme toughness in one direction, even at the expense of some toughness in the other. This can best be achieved by varying the amount of stretch, although the temperature may be varied to affect the amount of retained orientation. In either case, unmolding measures the effectiveness of the stretch as a recordable number. The normal test of bending a piece between the thumb and forefinger quickly sorts the very brittle from the non-brittle, but does not measure the degree of difference.

(Please turn to page 39)

Figure 2. The unmolding stress values depend on the temperature as shown for oriented Polyflex.

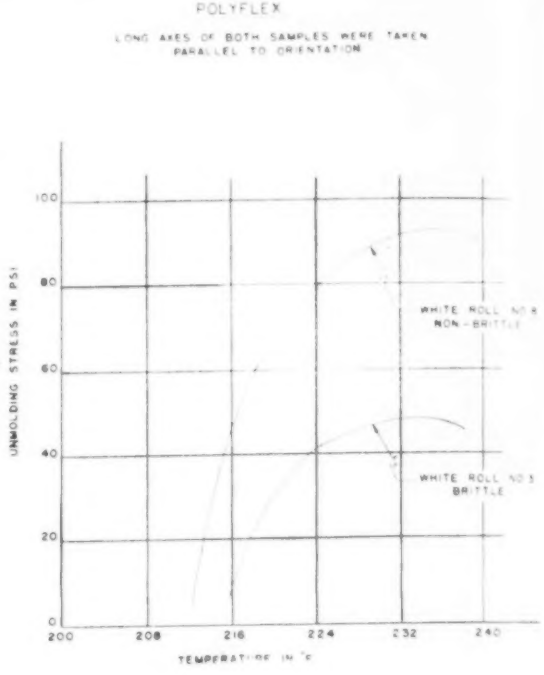
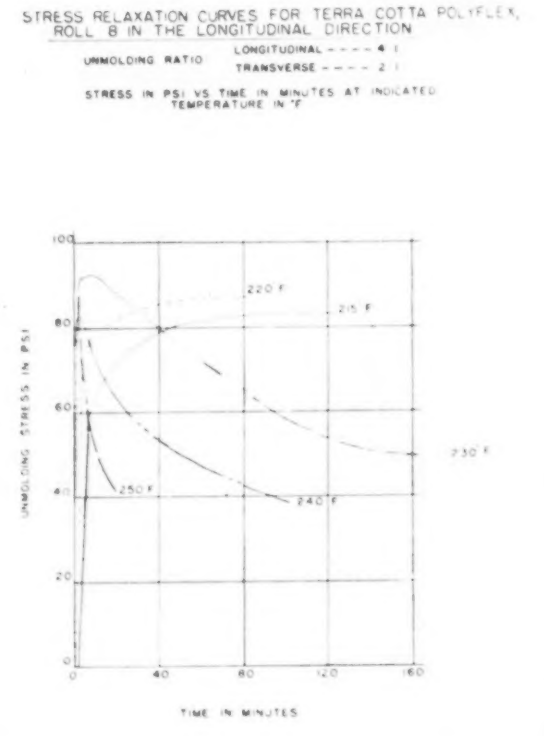


Figure 3. Stress relaxation relationships.



F. W. Reynolds

Plastics Applications In International Business Machines

F. W. Reynolds
International Business Machines Corp.

Presented at the Ninth SPE Conference

The plastics industry offers a greater variety of materials from which to select than any other class of materials.

What other group of materials offers such properties as transparency, unlimited selection of color, electrical insulation, heat resistance, light weight, high strength, sound deadening, and innumerable methods of fabrication. It is, therefore, reasonable to conclude that with intelligently applied product design, continued research and an intimate knowledge of consumer requirements, the plastics industry can be a powerful medium for the improvement and comfort of mankind.

A. GENERAL REQUIREMENTS

IBM MANUFACTURES electric and electronic accounting machines, time equipment and electric typewriters. The very nature of this equipment demands precision made components in which plastic materials perform a very necessary and important role. Therefore, the ultimate attainment in the use of the plastic components is a material or materials which have a minimum of dimensional change and maximum wear life under the varied atmospheric conditions to which our equipment is subjected.

It is also essential that the right material be used in the right place for the most satisfactory functional requirements. This is accomplished by selecting materials which have the properties best suited for the job. The general appearance and esthetic appeal is also given much consideration in the design of our equipment.

We use at least seventeen different plastic materials in the manufacture of our equipment. Let's look at some of these applications.

B. THERMOSETTING APPLICATIONS

In the thermosetting group are:

1. PHENOLICS

Control Panel—Most IBM accounting machines are equipped with control panels. Pluggable connectors are inserted in these panels to set up the machines for specific jobs. These wired panels are then inserted in a closing mechanism and brought into contact with a fixed panel equipped with spring contacts. Since contacts must accurately mate, it is essential to maintain accurate alignment both horizontally and vertically.

The control panels were formerly fabricated from a fabric base phenolic laminate. The change to a molded part was motivated by two requirements; first, better dimensional stability and, second, a less expensive part. It should be pointed out that quality is never sacrificed for cost.

Because of the close engineering tolerances required it was necessary to select a material with uniform shrinkage from batch to batch, and good dimensional stability. A high grade, general purpose phenolic was selected.

After consultation with many mold engineers, we decided that a compression mold had the best chance for producing the part to specifications. Hole locations had to be held to plus or minus .007" from the center to either end, in both the horizontal and vertical plane. Diameter of holes to +.002 and -0.000 and flatness to .020" total indicator reading.

Because uniform heating of the mold has a direct bearing on the molding shrinkage of the material which in turn determines the extent of stress molded in the part, it was decided to locate the core pins by alternate grouping from both the cavity and force side of the mold. The steam ports were then located at a uniform distance from the cavity on each half of the mold.

The construction of the retaining and guide plates for the core pins was also a problem because it was necessary to determine the amount of shrinkage which would occur in heat treating the steel plates before boring all the holes. Preliminary tests on a small plate indicated the extent of shrinkage which would be expected from heat treating of the full size plate.

These and other problems were solved and with the application of experienced molding technique, parts were produced to print specifications.

Circuit Breaker Cams—These cams are used to actuate electrical contacts which precisely time operations in IBM accounting machines.

Parts were compression molded for years from a phenolic impregnated paper, produced only by one vendor. Although the material was satisfactory for this application, it was classified s "special" which meant that any interruption in its manufacturing by the lone supplier would cause an inconvenience, to say the least, to IBM. Therefore, it was deemed advisable to seek another ma-

Plastic Components In Business Machines

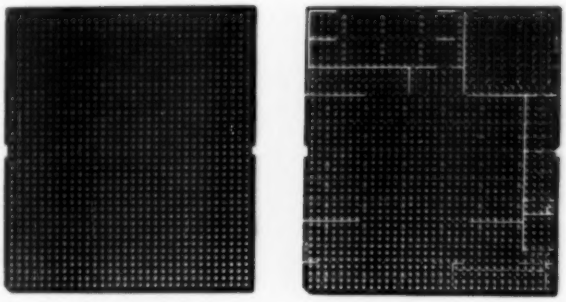


Figure 1. Compression molded accounting machine control panel.

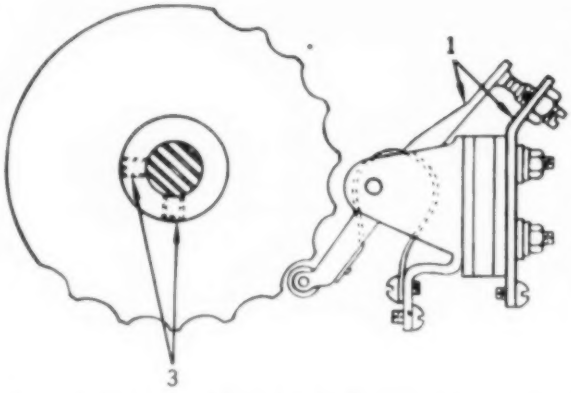


Figure 2. Circuit breaker cam for timing accounting machine operations, made of high impact phenolic.

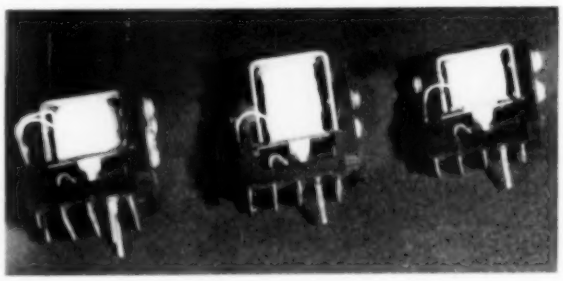


Figure 3. Seven different plastic components go into this complex wire contact relay assembly.

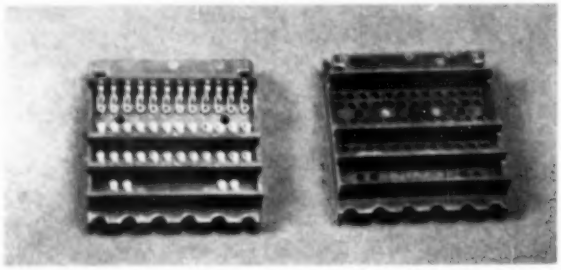


Figure 4. Wire contact relay terminal molded of Hycar phenolic.

terial or materials which would be equivalent to or superior to the "special" material.

As a result of test evaluations of other materials, one was selected as being at least equal in properties. This was a high impact phenolic which can be preformed, molds much easier, and has better machinability. It also gave a slight reduction in unit cost.

Wire Contact Relay Assembly Fig 3—Our wire contact relay is of unique design and has evoked considerable interest in the electrical industry. It derives its name from the fact that the contact springs consist of silver alloy wires. The relays are made in three sizes—with either four, six, or twelve transfer contacts and with a variety of magnet coil sizes and arrangements. The unit is pluggable to facilitate service and is small and compact to conserve space.

There are seven different plastic components included in this assembly; they are:

1. Heat Resistant Phenolic
2. Hycar Phenolic
3. Urea Formaldehyde
4. Punchable Grade Paper Base Phenolic Laminate
5. Non Rigid Vinyl Co-polymer
6. Nylon
7. Rayon

The relay frame is the major structural unit to which most of the other components are attached. It is plunger molded from a combination of 25% general purpose phenolic and 75% heat resistant phenolic. Included in the molding are two silver alloy inserts and one brass insert. The relative ease with which the general purpose phenolic can be molded overcame to a degree the difficulty involved in the molding of an asbestos filled phenolic.

The material choice for this part was dictated by two factors; dimensional stability and heat resistance. The operating temperatures of these relays will run as high as 160°F. After much experimental work and conferences with engineering, dimensional tolerances were established within practical molding limits.

Wire Contact Relay Terminal Fig. 4—This part is transfer molded; the material originally specified was an improved impact phenolic (cotton flock). It is now being produced from an Hycar phenolic.

An improvement in the impact strength of the part was found desirable because, rejections due to fractures and breaks around the holes were too high. There were two contributing causes to this trouble: the snug fit of the spring contacts into the molded holes and the insertion and removal of the tapered plugs into and from the spring contacts.

It should also be noted that the small wall sections and narrow contact supports necessitated the use of a low bulk material which eliminated the possibility of resin separation in the narrow sections.

With the introduction of Hycar phenolics with their low bulk factor and good impact strength it was felt that this material might do a better job on this part. Parts were molded from an Hycar phenolic and after testing the molded parts, particularly for resistance to cracking, the material was approved as a replacement for the cotton flock phenolic.

2. UREAS

Wire Contact Relay Armature Wire Guide Fig. 5—This part positions the wire contacts when they are actuated by the operation of the armature.

Many different materials were tested for resistance to grooving caused by the wire contacts. A urea plastic proved to be the best. The guide was first produced as a

separate part and assembled to the armature by a riveting operation. Experience in this method of manufacturing showed that there was a large amount of scrapped parts due to breakage.

We then molded the part directly to the armature and successfully eliminated the scrap due to breakage.

The accuracy which had to be maintained in the finished part is evidenced by the following tolerances: Parallelism or alignment of the holes within .003", distance between holes plus or minus .003", location of operating surface of holes from bottom of armature plus or minus .003", and flatness within .002".

Although the molding of the guide integral with the armature did eliminate assembly difficulties, we were confronted with equally troublesome molding problems such as maintaining necessary operating tolerances, shrinkage, cracking, hole alignment and warpage of the assembly. Some of these troubles were caused by the inherent high molding shrinkage of the urea.

The guides were originally designed and molded as a solid unit, held to the armature by a material lock through sheared loops in the armature. This method of holding the material to the insert or armature proved quite satisfactory. However, we discovered that even with these relatively small pieces the total shrinkage contributed to a high reject rate due to warpage, misalignment of holes and off-tolerances.

As a result of this experience the mold was redesigned to incorporate separating fins between each two-hole group, i.e., the four-hole armature guide had one separator, the six hole guide had two separators, and the twelve hole guide had five separators. At each two-hole group location the armatures were sheared to a narrow loop to provide a means of mechanically locking the urea to the insert. This change reduced rejections to an acceptable level.

It is interesting to note that of all the urea compounds which we tested, a very soft flow MUP32 color compound gave maximum resistance to grooving.

3. HIGH PRESSURE PHENOLIC LAMINATES

Brush Holder Block Fig. 6—Eighty multiple-strand fine brushes and their connecting plugs are assembled in this block. These brushes complete electrical circuits through holes in cards when the cards pass the sensing station. To insure proper contact, alignment of the brushes to the holes must be very accurate; therefore, very close tolerances must be maintained.

The function of this part dictated the use of an insulating material with high electrical resistance, good dimensional stability and relatively good machinability. These requirements were met by using a grade LE (fine weave fabric) laminate, purchased as a rectangular blank from which the part is fabricated to print specifications.

In our constant search for better materials, we eventually changed the specification from grade LE laminate to a random weave fabric laminate. Tests proved this material to be superior in machinability and dimensional stability and consequently replaced the original material.

With the hope of improving the part and reducing the cost, we are investigating the possibility of making this part by molding. We are conducting tests on parts molded from several different materials. The results look very promising, especially with a glass-filled alkyd.

Relay Insulating Spacers Fig. 7—These parts serve as insulating spacers between current carrying parts in many of our electrical units. In many instances as many as eight spacers and contact springs may be stacked in the assembly.

Plastic Components In Business Machines

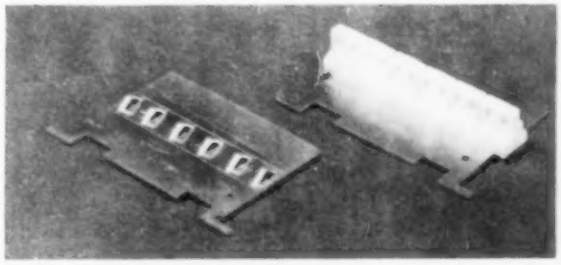


Figure 5. Armature wire guide of very soft flow urea gives maximum resistance to grooving.

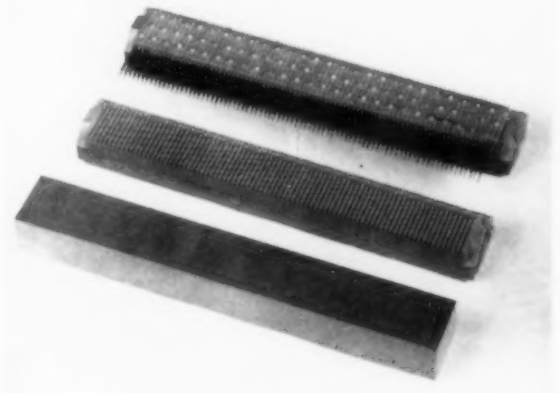


Figure 6. A random weave fabric laminate is used for this brush holder block. The brushes complete electrical circuits through holes in the cards.

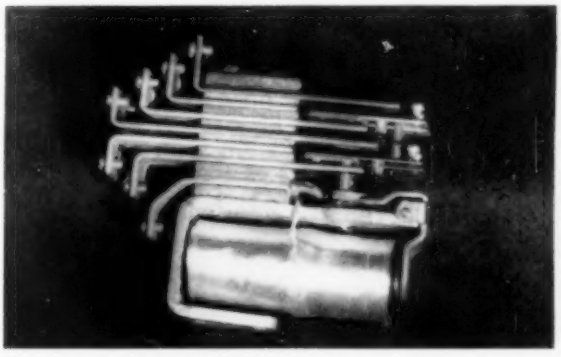


Figure 7. Insulating spacers made of punchable paper laminate.

The parts are supplied in various thicknesses ranging from 1 64" to ¼". The original material specification called for a NEMA grade paper base laminate. These parts were formerly purchased on a cold flow specification and samples were taken from each shipment and tested for this property.

Experience showed, however, that this specification was not sufficient to assure dimensional stability. It was discovered that the assemblies were loosening on units both in storage and in machines in the field. Investigation showed this loosening to be due to shrinkage of this part resulting from loss of volatile matter. In addition to the

Plastic Components In Business Machines

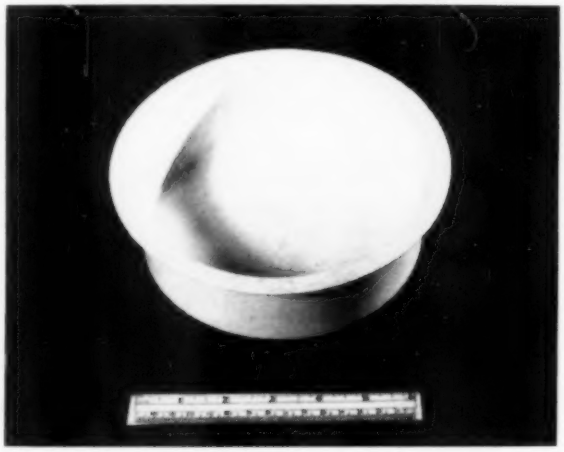


Figure 8. Polyester-fiberglas forms cover for a clock.

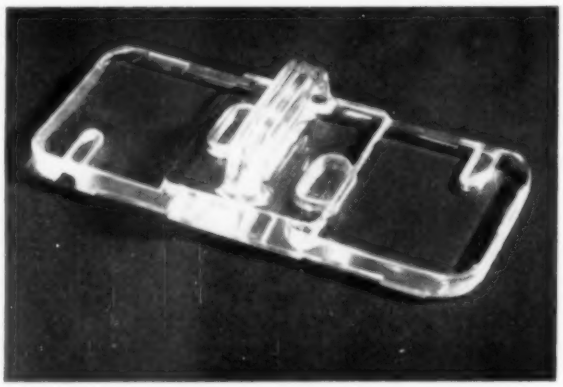


Figure 9. Methyl methacrylate is used as a weight to hold down cards in machine hopper.

shrinkage problem there were some instances where the assemblies swelled sufficiently to cause fracture of the heads of the retaining screws.

To overcome these difficulties the NEMA grade XX material was replaced by a special triple X punchable grade. This material has given assemblies with much better dimensional stability.

4. LOW PRESSURE POLYESTER-FIBERGLAS

This is a relatively new material in the plastics field. Its potentialities appear to be very great. We have been investigating this material for several years for housing and cover applications, and at present we are producing the dust cover (Fig. 8) for one of our clocks from it.

It is interesting to note that this part had been produced from steel, aluminum, vinyl, fiber, and finally, polyester-fiberglas. The initial fiberglas parts were molded from a preform and a non-flame resistant polyester resin. The wall thickness was .040". In order to conform to Underwriters' specifications for flame resistance and impact strength, it was necessary to increase the flange thickness to .060" and add a flame inhibitor to the polyester resin.

C. THERMOPLASTIC APPLICATIONS

1. CELLULOSE ACETATE BUTYRATE

Machine Cover Trim Extrusions—These parts were made originally from aluminum extrusions. When aluminum became scarce, it was necessary to find another material from which to make these decorative extrusions. This was accomplished by the use of acetate butyrate. A change in design and method of mounting of the extrusions was necessary in order to accommodate the plastic material.

2. METHYL METHACRYLATE

Card Weight Fig 9—The function of this part is to apply pressure to the cards in the machine hopper to permit proper feeding of the cards from the hopper. It was originally produced as a phenolic molding with a threaded hole in the center for the assembly of a chrome plated die cast handle. This material failed to meet the abuse of handling and dropping to which it was cortinually subjected in the field. The replacement of broken card weights demanded a material change.

Because the part is used on the outside of our machines, it was decided that careful consideration should be given to its appearance as well as its function. It was also decided that a transparent material should be used so that the cards would at all times be visible in the hopper. On the basis of these considerations the choice of material was narrowed to butyrate, polystyrene, and acrylic.

The part went through several design changes before final acceptance. It was originally decided to mold the part from butyrate, as this material would certainly take the abuse to which it would be subjected. Whether its blue tint would be acceptable was a question. After a field evaluation of hundreds of parts, we were advised that a colorless transparent material was preferred. Not only was the transparency of the butyrate unacceptable but its resistance to nicking was poor.

The transparency of the styrene was acceptable but its resistance to chipping, corner breaking and surface marring were very poor.

The acrylic stood up well in its resistance to chipping, nicking, corner breaking and general surface marring, and its transparency is outstanding. It is now being used to produce this part.

3. Vinyl

This is one of the most versatile of all thermoplastics because it is available in many forms such as coating, casting resins, rigid and non-rigid moldings and calendered sheets.

Some of our uses include vinyl-coated wire, heat resistant tubing for circuit identifications, dial indicators, platen cushions, electrographic pen barrels and vinyl-coated steel covers.

One of the most interesting applications is the vinyl-coated steel used for some of our machine covers. The appearance of our machines was enhanced by a change from a black wrinkle enamel finish to a gray wrinkle enamel finish. Although the gray finish was an improvement to the appearance of our equipment, it did not meet our requirements for resistance to general wear and scratching.

Motivated by the necessity of improving the wear qualities of the covers, which in turn would greatly reduce the maintenance time, a program was started for the purpose of finding a material that would have much better wear resistance without impairing the appearance. After due consideration and considerable investigation, the vinyl-coated steel seemed to meet all requirements.

A calendered vinyl sheet .020" thick is bonded to steel

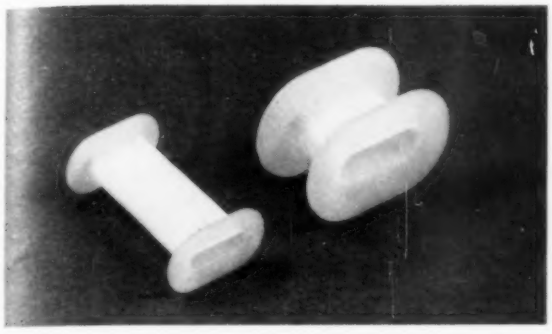


Figure 10. These magnet coil bobbins are made of nylon.

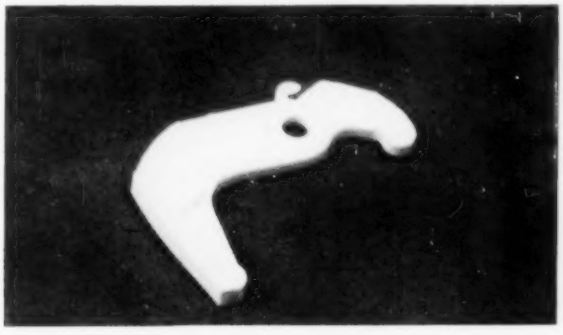


Figure 11. Electric typewriter cam which actuates a key is nylon, wear-resistant and tough.

in a multiple platen press and simultaneously embossed with a grained pattern on the surface of the vinyl. The sheets are then fabricated into covers by conventional sheet steel forming equipment.

One of our machines is being produced with vinyl-coated steel used for some of our machine covers. Extend the use of this material to other machines is being carried on.

4. **Nylon**

Nylon is a material characterized by its toughness, wear resistance and moldability in thin sections.

Magnet Coil Bobbins Fig. 10—A contributing factor in the increased operating efficiency and general improvement of many of our magnet coils has been the use of a flanged nylon bobbin as a replacement for the laminated phenolic tubing on which the magnet wire is wound. This change eliminated the use of a cotton interweave in the winding operation, increased the heat resistance of the sleeve and provided greater strength.

These results were not accomplished without molding and finishing problems. For instance, since all bobbins are produced in a split mold, it was difficult to hold the thickness of flash on the parting areas to the required minimum. The molders were also confronted with the problem of barrel warpage and maintaining inside diameter tolerances. It has been necessary to exercise close control in the molding technique and close inspection to provide bobbins with a minimum of rejections. It is generally necessary to remove the flash after molding. In this operation, the bobbins are loaded in a tumbling barrel with granite chips, alundum and water, and are tumbled to remove the flash.

Cams and Other Applications—We are also using nylon in the production of a cam used in our electric typewriter. (Fig. 11) Because of the toughness and wear resistance of this material, it has proved to be very satisfactory in this application.

Nylon is also being evaluated for gears and bearing applications.

CONCLUSION

Our experience in the design of molded plastic parts has brought us to the following conclusion:

There are four interdependent factors related to the production of a satisfactory molded item.

1. Good Part Design
2. Correct Material Choice
3. Proper Type of Mold and Mold Design
4. Experienced Molding Technique

A violation of any one of these will result in an unsatisfactory part. Adherence to all will be well rewarded.

New Books

INTRODUCTION TO THE THEORY OF STATISTICS. Victor Goedicke. Harper and Brothers, New York, 1953. 286 pages. $4.50.

We live in an age in which the use of statistical methods is becoming increasingly important in all branches of engineering, and it is therefore a pleasure to note the advent of a book which explains the fundamentals of statistical theory in terms simple enough to be understood by all practicing engineers.

The author has set himself the task of removing the theory of statistics from the realm of calculus and differential equations and making it understandable to any reader who can handle ordinary algebra, and on the whole he has succeeded admirably in this objective. The style is light and readable, and the theory is illuminated frequently by examples chosen from a wide variety of fields. Plastics engineers will be particularly interested in the tenth and eleventh chapters, which explain the theoretical basis for the sampling theory which is used in a variety of applications, and particularly in quality control.

In commenting on the purpose of the book, the author says: "It is not necessary to master the mathematical theory in order to use statistics; nevertheless there are cogent reasons for studying it. In the first place, an understanding of the theoretical basis for a procedure often brings with it an understanding of the limitations of the procedure, and the statistician with theoretical training is not likely to apply his procedures to situations where they are not suitable. In the second place, knowledge of the theory makes statistics a far more versatile tool in the hands of the worker. With the theory, he is capable of modifying his procedure to fit unusual situations, whereas a worker who knows only a set of specific operational procedures is helpless if the problem contains or unexpected ingredient."

Carl Denbow

THE *Injection* MOLDERSCOPE

By A. R. Morse
President, Injection Molder's Supply Co.

"It is the freedom to disagree, to quarrel with authority, in intellectual matters to think otherwise, that has made this nation what it is today." Dr. James B. Conant

HEATING CYLINDER MAINTENANCE.

One day in 1940, I was sent on a service call to the Prolon Plastics Division in Florence, Massachusetts to investigate a heating cylinder that was throwing a black streak. I still have a piece of the lucite that was coming out of this cylinder with a line of black down one side. Things really have not changed a great deal because today when we see a consistent streak of black or burnt material coming out of a heating cylinder, it is still almost a sure sign that a costly repair is coming up. Here are some speculations on heater troubles.

Heating cylinder trouble seem to fall into two patterns. First, there are always some shops that consistently have more heating cylinder trouble than others. Second, there are certain specific machines (regardless of make) that seem to give more trouble than others. As this article is being written, for example, there is a rash of cylinder trouble being encountered on a certain type of 24 and 32 oz. machines. When one gets calls from five different cities within a period of two weeks all concerning the same 32 oz. cylinder on the same make of machine, it begins to look as though there **must** be some common underlying cause for all of these costly simultaneous disasters.

However, let us first look at some of the shops that always seem to have more than their share of cylinder trouble. In these shops in general, you will find that the managements are reluctant to carry their share of the cost of repairing these cylinders and they refuse to admit that any specific operating conditions in their plant can possibly be the cause of the difficulty. We find that most molders are open minded on the subject of heating cylinder trouble, but there is a small group—I would not say more than 2-5% of the industry—that refuses to admit that their local operating conditions are the cause of the excessive heater repair bills which they are experiencing. These companies are always looking for outs, trying to get someone to build a "trouble-free heater," looking at stainless steel or cast alloy heaters, or arguing that the heater which is in trouble is defective in material or manufacture.

Now in our own case, when you have nearly a hundred heaters successfully running materials like vinyl, Kel-F, and butyrate and you find that trouble continuously crops up in the same shops, you cannot help but wonder if it is due to some supervisory oversight or the use of too generous a scale of rating the injection molding machine or other local problem.

We have pretty conclusively proven this because we have had several cases where the identical job has been run on identical machines in various shops. The heating cylinder trouble only occurred in specific shops which chronically have a great deal of heating cylinder trouble anyway, while the other shops ran the same material and the same job in the same cylinder without the slightest difficulty. If the cylinders were actually defective, there would certainly be a broader complaint than that amount of heater trouble to begin with; and these shops had just as much trouble with one design of cylinder as with another!

In a shop that is trying to do too large shots, or too many small shots per hour on a given machine, it is usually found that the cylinders are run very hot, sometimes as high as 700° to 750°. There is no denying that this technique can be successfully used. However, a single shut down or a single accident which allows materials to cook at these elevated temperatures can be the cause of the beginning of future heater trouble. This type of accident, however, I do not believe to be as big a source of trouble as the thermal strains discussed below.

Let us therefore look at the general principle of a heating cylinder and see if we cannot trace down much of the reason for unexplained cylinder failures. Almost every heating cylinder built today consists of an outer, round body of steel with a solid bar of steel in the center. There are many ways of supporting this solid bar of steel in the center of the cylinder, but let us not concern ourselves with this detail now. Virtually every heating cylinder in use today uses electric heat and this heat is controlled by a thermocouple which is inserted to a varying depth in the outer round barrel or tube of steel. The common depth of this thermocouple well is from ¼" to 1". This means that we are measuring the temperature of the barrel of steel relatively close to the outer surface where the heater bands are located. It has become a general practice when starting up a heating cylinder to set the pyrometer to operating heat—say 575°. When the heat reaches the desired point, the machine is started up and the operator assumes that he is ready for production. In many cases, plastic can actually be forced through the heater when the indicated temperature reaches the operating heat shown on the instrument. However, I am now convinced that there is a serious heat lag between the time the instruments show operating heat and the time the solid bar of steel (which we call the spreader) reaches the heat that it should be for proper operation of the cylinder.

The outer barrel has expanded and indeed, its surfaces may be as hot as they need to be for molding—the instruments tell you this. However, inside of the heater, we have this solid bar which has a serious heat lag and does not come up to the desired operating heat for some time after the instruments indicate that it is safe to start the machine. If you have a solid spreader construction or if you have a floating spreader construction, in either event, the fact that the spreader proper has not reached the same temperature as the surrounding steel tube or body results in the one case in a serious thermal tug-of-war taking place, or in the other, in an actual physical gap forming between the legs of the spreader and the outer wall of the heater. If operation is commenced before the spreader is fully up to heat, you add the tremendous pressures of injection to the thermal stresses already present in the heater due to the heat lag of the internal parts. We are coming to believe that 80-90% of all heating cylinder trouble can be traced to the fact that there is not sufficient warm up time allowed for the thermal stresses inside a heater to equalize themselves fully before the tremendous pressures of injection are applied to the cylinder.

If you will note the operating technique of shops that tell you they have no heating cylinder trouble, you will

(Please turn to page 40)

AROUND THE WORLD

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AUSTRALIA

AUSTRALIAN PLASTICS

Vol. 8, No. 90, January 1953

Abstracter: Albert Lightbody

PLASTICS AID IN CONSERVATION OF OLD PAINTINGS
by Dr. A. E. A. Werner

The restoration of paintings in the National Gallery, Trafalgar Square, has been carried out using modern materials with great success. Pictures, as Rubens' "Le Chapeau de Paille," Rembrandt's "A Capuchin Friar," Hans Holbein the Younger's "The Ambassadors" and Van Eyck's "The Marriage of Giovanni Arnolfini and Giovanna Cenami" are examples of those which have been restored. Modern methods using microcrystalline waxes for removing varnishes, polythene for sealing the backs of the canvasses, ethoxylene adhesives and polymethacrylic esters for coating have shown great improvements over those used previously.

STATIC DUST COLLECTION OF PLASTICS
by P. C. Woodland and E. E. Ziegler
By courtesy of the Dow Chemical Co.

Both positive and negative charges exist at random on the untouched surface of polystyrene. Dust patterns are formed which have little significance. Various treatments, such as exposure to radio active elements, X-ray and ultra violet radiation have limited usefulness in preventing dust accumulation. Destaticizers applied after molding have some degree of usefulness. Of the plastics tested, polystyrene appears the worst offender in dust collection followed by polymethyl methacrylate and polyethylene.

GLASS PLASTICS by R. H. Warring

A summary of the various processes used in the reinforced plastics field both in the United States and in Great Britain.

PLASTICS REPORT FROM ENGLAND by W. S. Penn

There has been a general reduction of plastics production in England during 1952 although there was a gradual increase near the end of the year. The larger manufacturers of P.V.C. have been putting on an extensive campaign to increase P.V.C. sheeting use. Polyester resins for bonding fiberglass are now being produced in Britain. Production of "Terylene" by I.C.I. is proceeding with a present production of 11,000,000 lbs. per year. I.C.I. has recently developed linear polyphosphates for many possible uses, chief among which is that for optical cements.

ADHESION BETWEEN LAYERS OF DIFFERENT POLMERS
by K. Thinius (Translated by J. N. Adams)

Reprinted from the S.P.E. Journal condensation of the original article from Kunststoffe.

Vol. 8, No. 91, February 1953

DEVELOPMENTS OF AUSTRALIAN PLASTICS INDUSTRY

The plastics industry in Australia has grown to a business employing over 5000 people. The majority of materials are thermosetting but importations of injection presses have started a thermoplastic boom. Raw materials are generally imported. Imports of fabricated items are still a principal source, primarily because other areas in the world can produce the tooling more cheaply.

PLASTICS NEWS FROM BRITAIN

Nylon C.A., a water alcohol soluble material has been introduced in Britain. New metallic powders for coloring plastics are now available. High styrene resins are now available such as Neolite, Latex, Litacrepe, Volite and others from the U.S.A. and Canada.

DYE TESTING OF PLASTIC MOLDINGS

Dye solutions are used to stain melamine moldings to determine completeness of cure.

THE FUTURE OF PLASTICS IN ENGINEERING

(An abstract of J. E. Gordon's Fourth Annual Lecture of the Plastics Institute—Reprinted from "Plastics")

PLASTICS IN PACKAGING — Phyllis Davies

Review of the outstanding exhibits of Britains third National Packaging Exhibition.

PLASTICS IN MODERN PACKAGING—Dr. Walter Ehlers

Survey of methods and materials for packaging.

VACUUM METALLIZING — J. Gordon Seiter

Reprinted from S.P.E. Journal.

THE ANALYST IN THE PLASTICS INDUSTRY — Lecture given by J. Haslam

Reprinted from "The Chemical Age."

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DENMARK

PLASTIC

Vol. 3, No. 2, February 1953

Abstracter: Erik R. Nielsen

SELECTION OF STEEL FOR PLASTIC MOLDS. Peer Svendsen.

The selection of steels for molds is discussed on the basis of the properties of the steels and the requirements to be met by the mold. Also a discussion of hobbing.

PROPER USE OF PLASTICS (conclusion). G. Terp.

Discussion of manufacturing costs and the properties of various plastics.

DEUTSCHE KUNSTSTOFFE. Rohstoffe, Waren, Hersteller. 1952. 296 pages. DM 16.80. Verlag fur Wirtschaftsschriftum, Otto K. Krauskopf, Wiesbaden, Bahnhofstrasse 61, Germany.

Handbook of the German Plastics Industry.

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FRANCE

INDUSTRIE DES PLASTIQUES MODERNES

Vol. 5, No. 3, March 1953

Abstracter: Hans Mayer

THE FRENCH INDUSTRY GETS EQUIPPED

After a delay, caused by the war, the French Chemical Industry is producing silicones now and will be manufacturing polystyrene and polyethylene molding compounds before the end of this year. Monomers for this production will have to be imported

for the time being. The manufacturing process for polystyrene chosen by the Societe des Produits Chimiques de Ribecourt for their resin plant is described in great detail.

THERMO-PLASTICS IN THE SERVICE OF THE TEXTILE INDUSTRY, J. Courvoisier

The development of the textile industry requires cost reduction in the preparatory field of manufacturing the threads. The article discusses the guides on the spinning machines which have been made from porcelain, molded from thermo-setting plastics, etc. and describes why all these have not been quite satisfactory. These are produced from practically all types of thermoplastic materials now. The spinning process itself creates static electricity and this condition is accentuated by the use of thermoplastic guides, the condition must be overcome by the proper installation of nylon condensers.

A COMPARISON OF THE FRENCH AND AMERICAN INJECTION MOLDING INDUSTRIES

The injection molding industry in France is highly specialized and there are no molders using injection presses and other means of molding as compression or transfer presses under the same roof. The average molding shop in France has three injection machines compared to an average of six in the U.S.A. The average capacity per machine is 98 grs. compared to 385 grs. and the average total capacity of the injection molding equipment in the French shop is 308 grs. compared to 2360 grs. for the U.S.A. The most popular machines in the French industry have a capacity of 1 to 2 ounces compared to the most widely spread machines of from 4 to 8 ounces capacity here.

THE SEALING OF POLYETHYLENE BY INFRA-RED IMPULSES, M. Kerhoas

On account of its excellent dielectric properties the use of high-frequency sealers is impractical for polyethylene films. However, the sealing can be accomplished after the material has been exposed for a controlled period of time—between 3.10 and 8.10 seconds—to infra red radiation. The apparatus for this procedure is described.

NON DESTRUCTIVE TEST OF MOLDED SPECIMENS

Surface cracks can be exposed without complicated machinery by covering the molded part with fluorescent ink and exposing the part after drying to ultra-violet light. Such ink is sold under the trade name of "Glomor" by the Manchester Oil Refinery, Ltd. The test specimens have to be free of all traces of oil and fat and should be degreased before the test.

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GERMANY

KUNSTSTOFFE

January 1953

Abstracter: Anne Schwend

INSTRUCTIVE SHOW AT THE PLASTICS FAIR AT DUESSELDORF by Dr. J. Hansen

A synopsis of the applicability of plastics in every-day life, as demonstrated in an instructive show at the last Plastics Fair ("The Plastic Home" consisting of bathroom, kitchen, living room, playroom for children and a bar room as well as office rooms had been built up wherein furniture, fittings and decorations were made solely of plastic materials), and their structural composition as well as standardization. The specific properties of plastics could be tested on a number of specimen and special testing devices which were handled by the visitors themselves.

EXPANDED PLASTICS CASTS FOR MEDICINAL PURPOSES by Dipl. Ing. H. A. Schwab

The use of expanded plastics for putting into a cast fractured bones etc. is the subject of extensive research work. Advantages of such casts are represented by their termoplastics moldability, flexibility, hygienic superiority and the fact that the skin may easily respire under the cast. Easy removal or remolding without removal will permit to correct the position of fractured bones and re-use of the same bandage. Expanded plastics are supplied in handy-sized plates, molding of which is done at 60 to 70 C. The bad thermal conductivity of expanded plastics will allow such temperatures without causing discomfort on the side of the patient. A considerable reduction in weight in comparison to plaster casts and above all practically unimpeded X-ray transmission add up to the advantages enumerated.

INFLUENCE OF THE MOLECULAR WEIGHT ON THE PROPERTIES OF POLYSTYRENE by Dr. Ing. H. R. Jacobi

The contexture and fragmentary results so far published on the influence of the molecular weight and its distribution on the physical properties of non-oriented, strain-free polystyrene films — as first investigated by E. H. Merz, L. E. Nielsen and R. Buchdahl and published in Ind. Engng. Chem., volume 43 (1951), are evaluated from another angle by the author. Formulas found partly differ from those already known. Investigations also encompassed other high polymers which behaved in similar fashion as polystyrene.

DETERMINATION OF THE SPECIFIC HEAT OF VARIOUS PLASTICS DEPENDENT ON TEMPERATURE. by Dr. Ing. Th. Gast

Three different ways for determining the specific heat of plastics, particularly polyvinychloride with and without plasticizers, are described: (1) heating in a calorimeter filled with water; (2) by means of a steam calorimeter, and (3) by means of a calorimeter with uninterrupted even heat supply for the specimen. The results obtained show the well-known jump at the freezing point which appears as buckling. The addition of plasticizers strikingly mitigates this jump.

MODERN LACQUERS FOR WIRE INSULATION by Dr. A. Wiegandt

Though high molecular compounds were known in Germany, they were not used as raw materials for wire-lacquers until 1949 in contrast to their wide utilization in the U. S. A. The lack of information on processing, application and possibilities for combination did not allow to surpass the laboratory stage. However, great progress has been made since then and is still under way. Development is now keeping pace with demands. The field of high molecular compounds has only been partly discovered for wire insulation but utilization is constantly gaining in importance while that of condensation products is falling off. A general survey of materials used completes the article.

A COMPOUND CURVED HONEYCOMB CORE MATERIAL FOR SANDWICH PANEL CONSTRUCTION by Austin H. Herbst

A reprint from the January 1952 edition of the SPE Journal.

MACHINING OF PLASTICS WITH CEMENTED CARBIDE TOOLS by Dr. Ing.habil. Dr. J. Witthoff

This article gives any cutter a survey on the machining possibilities for the various kinds of plastic materials and particularly the hard metals most advantageously used for tools. Means and ways for grinding and regrinding of tools, cutting angles, removal of plastic particles sticking to the cutting edge with the help of solvents and other pertinent problems are discussed. It is regretted that in most cases high-speed cutting machine-tools are not available which makes it so much more necessary to pay particular attention to the proper shaping of tools and careful grinding of same.

DETERMINATION OF THE MOLECULAR WEIGHT OF HIGH POLYMERS by Dr. Ing. Klaus Stoeckhert

Today plastic molders pay more and more attention to the molecular size and structure of high polymer compounds due to their influence on the mechanical properties of the materials. While, in Germany, it has become

almost common use to identify and classify PVC according to its "k-value" determining same for a solution of 1% of the polymer powder in cyclohexanone, in the U. S. A. the specific viscosity of a solution of .4% of polymer in nitro-benzene is measured. Hence, the German and U. S. values cannot be compared without hesitation. A table as well as a diagram show the context between viscosity and "k-value" for various concentrations of PVC as well as the dependency of the "k-values" from concentration. Writer refers to a pamphlet issued in 1941 by the Badische Anilin- und Soda-Fabriken under the heading "Determination of the viscosity of solvatized sols" (Die Messung der Viskositat solvatisierter Sole") with the help of which the "k-value" of the types of polyvinylchloride offered by the Dow Chemical Co. can easily be calculated.

REDUCTION OF SETTING PERIODS FOR SYNTHETIC RESIN GLUES BY MEANS OF RESISTANCE HEATING by E. J. Ritter

The advantages and technique of glueing ply-wood (up to 10 mm in thickness) and laminated plastics by means of synthetic glues and electric band heaters are described, encompassing the arrangement of the band heaters, switching diagrams, power consumption and resulting reduction of setting periods to one tenth and less which helps to economize in glueing equipment. The savings thus made exceed by far the cost of installation of the band heaters plus current power consumption.

KUNSTSTOFFE
February 1953

EDITORIAL

Thinking and Acting in European Terms

During the traditional New Year's Eve Party of the Chamber of Industry and Commerce in Hamburg, the Chamber's President pointed out with regard to British-German competition on export markets that the rivalry of the European governments would be an inevitable consequence of their distorted foreign commerce policies which could only be remedied by close collaboration of all West European national economic organizations. A comparsion of the German and British measures would demonstrate that nothing is being neglected on one side what is being done on the other. Great Britain and Germany have always been great competitors on export markets and so they will continue to be. Competition, however, has to be fair and should not induce one party to use dumping measures. Germany acknowledges Great Britain's justified interest and duty to expand on exports, but claims the same rights for herself. This opinion is enlarged upon and its applicability to the German plastics industry stressed.

EDITORIAL

Glass Fibre Laminates

Abstracts from British Plastics 1952 reporting about an informational convention held in England in May 1952 for the purpose of dealing out news about glass fibre laminates.

GERMANY OFFERS PLASTICS AT THE DUESSELDORF FAIR
by Dr. Ing. E. Escales

The abundance of news from the plastics industry, as exhibited at the plastics fair in October 1952, is reviewed and subdivided into basic and raw materials, auxiliaries, plastic products and machinery. To a large extent the manufacturers and their specific products are listed. Where general information on a certain group of products seems to be warranted, same is given. The following appears to be of particular interest.

a. Basic and Raw Materials

Among the **condensation products** raw materials for lacquers "Alpex 450 J" (a hydro-carbon resin) and the "ALU Alftalates" of the Chemische Werke Albert, Wiesbaden, were introduced. The same company exhibited a plastic typewriter, structural and functional parts of which were all molded. Their new special molding compound "S291 So" is particularly suited for high frequency parts.

In the field of **phenolics and aminoplasts** the Bakelite GmbH of Letmathe exhibited for the first time caoutchouc modified molding compounds the properties of which show high elasticity and impact strength.

Melamine formaldehydes are now supplied by Henkel & Cie. GmbH. Duesseldorf. Sueddeutsche Kalkstickstoff-Werke, Trostberg Bavaria, appeared as suppliers of melamines and a number of important basic materials such as dicyandiamide, guanidine salts as well as thio-ureas.

As to laminates, the "Dekos-Vertriebsgesellschaft dekorativer Schichtstoffe mbH.", Wahn Rhineland, introduced themselves as distributors of "Formica decorating plates" production of which has now been started in Germany on the basis of the British pattern. The applicability of "Resopal aminoplast laminates" by Messrs. Roemmler or Gross-Umstadt for wall- and furniture covering as well as refrigerator lining and illumination purposes is reviewed in detail.

"Nyhapren," a **rubber-like plastic material** which is supplied hard and soft by New York-Hamburger Gummi-Waaren Compagnie of Hamburg and is oil, fat, acid and lye resistant, was exhibited as semi-finished product and in form of highly heat resistant molded parts and linings.

Among the **polyesters** shown particular mention is made of the cast resins P1, P2 and P3 which are free from solvents and non-saturated, produced by Badische Anilin- und Soda-fabriken of Ludwigschafen and the great variety of polyester resins offered by Farbenfabriken Bayer of Leverkusen. In the fibre field "Terylene" based on ethylene glycol and terephthalic acid will have to prove in how far and to what extent it can compete with Nylon and Orlon.

Polyadducts list among others "Vulcollan" made by Farbenfabriken Bayer which exceeds the wear and chemical resistance of natural caoutchoucs, and the possibility to maintain this resin in a castable stage opens up undreamed of ways of processing.

Badische Anilin- und Sodafabriken exhibited their new "Styropor" **light weight material** on the basis of polystyrene, an excellent insulator the specific weight of which can be reduced to 0.025 grams per cubic centimetre.

Silicones were shown by Dr. Alexander Wacker, Munich, and Farbenfabriken Bayer which latter have now also taken up this branch of production.

As to **polymerizers**, particular attention was paid to the polytrifluorchloride-ethylenes of the Farbwerke Hoechst "Hostaflon" and its dispersion "Hostaflon D" and of the Farbenfabriken Bayer "PF-Kunststoff." Farbwerke Hoechst exhibited a diaphragm made of Hostaflon which, for a year, had been exposed to moist chloride mixed with some sulphuric acid and did not show any sign of wear.

Badische Anilin- und Sodafabriken now produce polyvinyl carbazole for injection molding also in transparent colors.

Both the Badische Anilin- und Sodafabriken and the Chemische Werke Huels exhibited new polyvinylidenchloride dispersions and co-polymers. The former is again on the market with polyisobutylene (Oppanol B dispersions).

An improved form of plasticizers was shown by Imhausen & Co. ("IW 100 Special and IW 110 Special") the light permeability values of which equal zero. Acid values are extremely low in comparison to the older type materials. The same company also exhibited for the first time stabilizers (chloride paraffines) and "Witarix TF" as auxiliary for the caoutchouc and plastics industries.

b. Plastic Products

Among the hundreds of articles listed the following were marked as having received particular attention:

Window frames from extruded profiles on phenolic base,

Slide elements of volcanic fibres,

A sedan of the "Volkswagen" type with 139 individual plastic parts,

Artificial leather (coated plush material) for dresses,

Elegantly shaped chairs showing a nice combination of plastics and steel tubes.

c. Machinery

Messrs. Hermann Sohn, Duesseldorf, came out with a new kind of quick mixer. The high speed of the mixing blade rotating around the horizontal

axis attacks the material easily so that the processes of mixing, solving, homogenization and emulsification of compact and liquid materials are accelerated to an extent that opens up new possibilities for the introduction of reactions.

A new vertical injection molding machine for 40 grams piece weight, electro-mechanical drive, which is particularly suited for molding in metal parts, received much attention (Messrs. Battenfeld, Meinerzhagen).

Eckert & Ziegler GmbH of Weissenburg Bavaria presented the model of a small injection molding machine with electro-hydraulic drive, the principle of which shall be used for a 1 oz. machine.

A new 5 oz. injection molding machine was introduced by Messrs. Albert Stuebbe of Vlotho(Weser)-Kalldorf: very simple construction, heavy design of mold closing device, division of the heating cylinder into various small heating cylinders assuring even heating of molding compound, low consumption of pressure liquid.

Messrs. Walter Tueckmantel, Solingen-Wald, showed their latest models of fully mechanical and fully automatic injection molding machines "Tumax M." Mold closing and injection sides are being switched by means of electro-magnetic couplings as hitherto known only for machine-tools and rolling mills. The running sound of the machines has almost been deadened. Capacities: 1, 1½, 2½ and 3 oz. The closing system of the "Tumax H" molding machines in which four toggle levers attack the pressure plate at the four corners and which use infrared radiation for heating the heating cylinder received special consideration.

Messrs. Josef Eck & Soehne, Duesseldorf, called the molders' attention to their new "mixtruder," a mixer and gelatinizer for thermoplastics built as a sort of double screw press. The flight of the screws is interrupted to form kneading blades. This mixtruder does the job that hitherto had to be done on two separate machines, i.e. mixer and rolling mills. Further, it can be used for direct molding of hard or soft thermoplastics as well as granulation.

Maschinenfabrik Ruth Schwabenthan, Berlin, have arranged a third roll in L-like position to the other rolls on a normal mixer-rolling mill, which during operation can be either shut off if not needed or put into close contact with the other rolls so that all mixing and rolling processes and, with the help of the third roll the drawing of plates and foils can be executed thereon.

New screw presses are offered by Armaturenfabrik Johann Fischer of Lohmar (district Cologne) with screw diameters of 32 and 50 mm which are also adaptable to processing of polyamides.

An interesting design of double screw presses for pre-gelatinization, mixing, coloring, homogenization and molding of PVC, Polystyrene, polyethylene and others was offered by Harburger Eisen- und Bronze-Werke AG of Hamburg-Harburg. Special design of the head will also permit the extrusion of tubes and profiles.

A number of new developments, such as an automatic strength tester for films, a double folding tester (system Koehler-Molin) and an abrasion resistance tester were offered by Messrs. Karl Frank GmbH. of Weinheim-Birkenau.

MACHINING OF PLASTICS WITH CEMENTED CARBIDE TOOLS (Continuation)
by Dr. Ing. Dr. J. Witthoff

While the foregoing article in the January 1953 edition dealt with carbide tools used for machining plastics, this one elaborates on the various kinds of machining applied (cutting, turning, boring, frazing, sawing, thread cutting, etc.). The use of carbide steels for molds, however, showing 25 to 50 times the wear resistance of normal steels, will be considered in many cases as not warranted due to the relatively small number of molded articles needed.

INJECTION MOLDING OF VINYL
by A. R. Morse

Abstracts from the April 1952 edition of the SPE Journal.

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DER PLASTVERARBEITER

Vol 4, No. 2, February 1953

Abstracter: E. C. Bernhardt

DESIGN OF MOLDED PARTS
By K. Brandenburger

It is important to allow for the physical limitations of plastic materials in designing the finished products in which they are to be applied. Illustrations of the proper use and design of metal inserts for various applications are given. Parts should be designed to avoid excessive local stresses.

Housings to be molded in mottled colors will show the location of inside ribs on the outside surface through changes in the flow of the material. If this is to be avoided, small decorative ribs can be applied on the outside, and the space between these can be filled in with a lacquered metallic stripe.

Difficulties in the production of undercut sections are illustrated, and simple means for producing small undercuts or lips are shown.

INTERNAL AND EXTERNAL PRODUCTS ON MOLDED PARTS
By H. Spies

Techniques and sketches of mold constructions for small undercut parts. Illustrations include a design for a wheel for a calculator with undercut numbers. Cost for a 5 cavity mold is the equivalent of about $600.

NEW CONSTRUCTION FOR A COMPRESSION MOLDING UNIT

A new compression molding machine is described, consisting of several small jointly actuated compression units on an indexing table.

SUCCESSFUL APPLICATIONS OF SILICONES

The physical properties of various Silicones are described, and their usefulness in engineering applications is illustrated. German production of Silicones is to start this year.

REASONS FOR VERTICAL INJECTION MACHINES

Advantages of easier positioning of inserts are discussed. Molds do not need elaborate mountings. The use of "twin molds" for small items is described. While one of the mold cavities is being filled and is under compression, the other is positioned outside of the platens, and is being cooled and discharged.

CONSTRUCTION OF MOLDS FOR PARTS WITH TWO THREADED SECTIONS by A. Urbanz

Sketches of a method employing a removable threaded mold insert are given.

NEWS ABOUT HIGH FREQUENCY APPLICATIONS IN PLASTICS PROCESSING by J. Brandenburger

A method for producing multicolored small items from cellulose acetate is mentioned. Teflon coated electrodes with a soft rubber insert are used for sealing liquid filled PVC tubing.

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GREAT BRITAIN

BRITISH PLASTICS, March 1953
February 1953

Abstracter: Herbert R. Simonds

EDITORIAL: (1 page)
Productivity and the Molder

A team of British molding experts visited the United States last year to study productivity in the plastics molding industry, and their report has just been published. They state "Large orders often justify more expenditure on equipment and on more detailed study of individual jobs."

The report itself is included in this issue of British Plastics. In general the team stated that if quantity requirements justify the initial expense the present practice, both here and in the United States, is to mechanize production methods and so increase productivity per hour.

THE MOULDING OF ELECTRICAL ACCESSORIES (5 pages illustrated)
by A. L. Sparshott

Phenolics were the chief plastics

used for electrical accessories in the '20's mainly because they had the following properties: insulation, heat resistance and non-inflammability, strength, moldability. In the '30's new materials began to appear; chiefly, urea and new types of phenolics; also, extensive mechanization of production was developed. A switch base, for instance, on a multiple capacity mold was produced on an electric push-button operated press. Recently polystyrene has offered the first serious challenge to the thermosetting materials. The development of polystyrene is fast overtaking phenolics in the general field, but this is mainly due to the use of polystyrene outside the electrical industry. Nylon-filled phenolics which are a British development possess good electrical properties and will have increased use in the electrical industry.

CROSSLINKING OF POLYTHENE IN THE ATOMIC PILE (3 pages with graphs)

Some polymers, notably polythene, polystyrene and nylon become crosslinked when subjected to radiation in an atomic pile. The crosslinking of polythene is described in considerable detail. Apparently it is possible to use crosslinking in this thermoplastic which changes its character to more closely resemble thermosetting materials. Under radiation the crosslinking appears to be caused by the removal of hydrogen atoms. This discovery was made by Dr. A. Charlesby at the Atomic Energy Research Establishment, Harwell, England. Dr. Charlesby sums up the possibility of this new crosslinking process as follows: "In the first place it provides means of producing materials with any required degree of crosslinking which can be determined on a relative standard to a high degree of accuracy). This can be accomplished without heat treatment, which might affect the properties of the material and without the introduction of foreign atoms. Since the mechanism of crosslinking is quite different from that used in chemistry, a wide range of new plastics materials can be synthesized. The method also permits such subjects as mechanical, electrical and optical properties to be studied as a function of the degree of crosslinking. A new method of molecular weight determination may be developed, as appears likely from our experiments on polythene. Polymers with any required degree of orientation or strain may be locked in position by irradiation. Indeed, the process is very similar to that of vulcanization of rubber, but has the advantages of being applicable without heat treatment or incorporation of foreign atoms, under rigorously defined conditions to a variety of compounds even of a saturated character."

NEW TRENDS IN THE PRINTING AND FINISHING OF VINYL SHEETING (5 pgs. ill.)
by Dale G. Higgins

This article is based on an address given by Dale G. Higgins of John Waldron Company of the United States at a December meeting in Boston. The original article has been given considerable publicity in this country.

Future trends in the decoration of vinyl sheeting are given as follows: there probably will be an increase in the use of ink embossing technic accompanied by multi-colored ink embossing in register. Also, it seems likely that there will be a substantial increase in volume of products manufactured by the embossing-lamination technic. This would include vinyl web to vinyl web as well as vinyl webs to non-woven webs.

MOULDED POLYTHENE SHEET FOR SURGICAL APPLIANCES (3 pages illustrated)

First a cast is taken in the hospital by a trained worker. After this is set the shell is stripped away and the surface of the mold is smoothed off with care. The mold is then covered with a piece of stockinet, the joints being covered with cellulose tape. A sheet of polythene of the right dimension is then heated in an infra-red oven to about 120° C. It is then molded around the plaster form. This must be done with care to insure that the polythene conforms to the mold. After cooling, edges are finished and air holes are punched to enable the form to breathe.

CORONATION SOUVENIR AWARDS (2 pages illustrated)

Five important plastics materials are used: cellulose acetate, polystyrene, acrylic, vinyls and ureas.

PLASTICS APPLICATIONS (4 pages illustrated)

Among the new items this month are the following:

1) Headlamp Housing
2) A mathematical instrument known as a Divigraph
3) Telephone cables insulated with polythene
4) Polythene squeezable containers produced by Fibrenyle Ltd.
5) Door spring buffer
6) Vinyl material used as a separator in car batteries
7) Acrylic door furniture and,
8) Parts of a photograph developing machine.

AMERICAN PRODUCTIVITY
by M. Freund

This is an excerpt of the report prepared by the British productivity team which visited this country. Figures relating to a performance of a group of factories are given along general lines and somewhat evasively.

Recommendations made by the Productivity Team: This gives a list of fourteen recommendations as a result of the report on the previous pages.

MISCELLANEOUS

A process is described for the shrink covering of rods, bars or tubes with p.v.c. material.

The Lemans car which is an experimental type produced by Cadillac has body work molded in glass reinforced plastics material.

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PLASTICS

February 1953

Abstracter: A. T. Rexer

MECHANIZED PRODUCTION OF FOUNDRY SHELL MOLDS FROM RESIN/SAND MIXTURES

A description of the Polygram Automatic Shell Molding Machine Mark IV which mechanizes the method of making shell molds from shells of sand bonded with a phenolic resin binder (see recent issues of "Plastics," August 1952 and November 1952). The article is well illustrated.

CELLULOSE ACETATE BUTYRATE
by E. E. Halls

The third and concluding part of an article in which the author compares the properties of cellulose acetate with those of cellulose acetate butyrate. Specifically, this part deals with films manufactured from these materials, giving detailed results of tests for water absorption and dimensional stability.

POLYSTYRENE EMULSION PAINTS

This article gives details as to the formulation and production of polystyrene emulsion paints as obtained from a laboratory report of the work on the subject as carried out by the Development Division of the Monsanto Chemicals, Ltd.

PLASTICS IN THE SERVICE OF MAN

A pictorial review of high-quality units molded or otherwise fabricated in Great Britain. It contains a series of photos of units used by the refrigeration industry.

NATIONAL PACKAGING EXHIBITION

A description of the role that plastics plays in packaging as shown in the National Packaging Exhibition held last month in Great Britain.

PLASTICS RESEARCH IN HOLLAND

A two page article describes and illustrates the work that is being car-

ried out at the Plastics Research Institute, T.N.O., at Delft, Holland.

NEW PRODUCTIONS

Descriptions and illustrations of the latest plastics articles being produced in Great Britain.

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TRANSACTIONS OF THE PLASTICS INSTITUTE (London)

January 1953

Abstracter: Harriman H. Dash

THE FUTURE OF PLASTICS IN ENGINEERING (pages 5-17)
J. F. Gordon

The position of plastics in industry is likened to the Industrial Revolution occasioned by the introduction of metals in the early nineteenth century. The paper presents a general plea for a more rapid and bolder extension of the engineering application of plastic materials. The author discusses several possibilities of such extension, particularly in the aircraft industry, and points the way to several new approaches. A few examples of comparative cost between the use of metals and plastics are presented. On the whole the paper is oriented about British needs. Due to that country's limited resources, it has to compensate by keeping technically ahead with new ideas.

THE INFLUENCE OF PLASTICIZERS ON VINYL STABILIZATION —W. G. Vennells

High temperatures and ultra-violet light initiate HCl separation from vinyl chloride polymers; the acid autocatalyzes further splitting-off of HCl with consequent degradation of the polymer (evidenced by color changes, brittleness, decreased physical properties). Stabilizers absorb or neutralize the acid thus retarding recomposition of the resin. Metallic soaps which make good stabilizers are also good lubricants. Stablization is a function of other components (resin, filler, plasticizer) as well as processing conditions. Research covering numerous plasticizer stabilizer systems are detailed. The main conclusions reported are: (1) Dibutyl and dioctyl phthalate plasticized compounds are easier to stabilize than tricresyl phosphate systems. (2) Cadmium laurate and palmitate are excellent stabilizers for all systems.

Symposium on Calendering Plastics
TECHNIQUE OF CALENDERING (pages 31-43) **A. D. Clarke**

This deals primarily with thin vinyl sheeting (.003-.005" thick). The section on calendering is preceded by a discussion of the selection of raw materials and preparation of the compound. The resins, (vinyl chloride polymer or copolymer) should have good stability and dispersability. Pigment and lake colors are preferable to dyes. They are added as ground pastes in plasticizers. Stabilizers are also best added in paste form. Stabilizer selection for transparent sheet is critical; the trend has been for the selection of admixtures of stabilizers with synergistic effects. Choice of plasticizer depends on end use; low volatility and good compatibility remain essential requirements. Polymeric type plasticizers are receiving increased attention but competitive economics still limit their use to specific applications.

For high quality sheeting, a 4-roll calender and precise heat controls are essential. The gauge is normally controlled by gap adjustment. High pressures (up to 8000 psi) may be built up between bank (fed material) and roll, resulting in bending of latter and consequent transverse variation in gage. Longitudinal variations may be caused by differences in take-up speeds and temperatures. The possibility of automatic control by beta-radiation measurement techniques is suggested. Trimming, surface-finish, and defects, calender speeds, lubrication, and rework are also covered in this paper.

TYPES OF MACHINES AND LAYOUTS (pages 44-55) **Joseph Brown**

In this second paper of the symposium, the author presents schematic diagrams of the inverted-L, Z, and superimposed 4-roll calenders. Good roller design is discussed in relation to temperature distribution. Preloaded and zero-clearing bearings lessen the need for exacting feed control. Flood oiling is employed for economic and adequate lubrication under thermal control. Cross-axis adjustment of the roller is successfully used for gauge correction, especially in conjunction with unit-drive gearing. Recent trends in equipment layout are to provide for greater accessibility. Several schematic diagrams of layouts are provided.

DISCUSSION AND QUESTIONS (Pages 55-62)

Specific and varied questions on the subject are recorded along with the answers provided by the authors of the symposium.

The two papers and accompanying discussion of the symposium should make very profitable reading to those interested in calendering.

SYNTHETIC POLYMERS IN TEXTILE FINISHING — J. G. Evans and G. Landells

A finishing material is employed to impart some desired property (softening, stiffening, water resistance, dyeability, etc.) to a fibre. The use of synthetic polymers in textile finishing is dependent upon (1) applicability from aqueous medium (2) improved functionality over natural finishing polymers. For best results the polymers are formed in situ from primary condensates or monomers. Amino-formaldehydes provide improved crease resistance; keto-aldehydes improved dimensional stability and wet-strength; cyanamid resins improved dyeing and fire-resistance. Other polymers used are silicones, PVA, vinyls, acrylics, etc. The addition polymers are used primarily in the pre-formed condition. The chemical relationship between polymer and fibre is discussed technically and evidence cited for the various possible linkages postulated. Several paragraphs are devoted to the use of synthetic polymers as direct sources for fibres. A very active and interesting discussion on the subject follows the formal paper.

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SPAIN

REVISTA de PLASTICOS

Vol. 4, No. 9, Jan.-Feb. 1953

Abstracter: John B. Ballard

TERYLENE, BUNA, AND PLEXIGLASS FROM NATIVE RAW MATERIALS—J. Aleman Vega

Discussion of derivation of various plastics from turpentine, a raw material which is plentiful in Spain.

STABILIZATION UNDER HEAT OF VINYL COMPOUNDS — Jesus Lumbreras

Heat stabilization of polyvinyl chloride, as affected by resins, plasticizers, stabilizers, and lubricants

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UNITED STATES

Abstracter: J. J. Lamb

National Advisory Committee for Aeronautics
Technical Note 2717, June 1952

EFFECT OF TEMPERATURES FROM –70 TO 600F ON STRENGTH OF ADHESIVE-BONDED LAP SHEAR SPECIMENS OF CLAD 24S-T3 ALUMINUM ALLOY AND OF COTTON- AND GLASS-FABRIC PLASTIC LAMINATES
by H. W. Eickner, W. Z. Olson, and R. F. Blomquist (26 pages)

14 adhesives were tested for possible use in sandwich constructions for aircraft. Included were adhesives based on 1) thermosetting and neoprene, 2) phenolic and Buna N, 3) modified vinyl, 4) silicone, 5) vinyl-butyral and phenolic, 6) epichlorohydrin (epoxy), 7) modified vinyl butyral, 8) polyester, 9) resorcinol, and

(Please turn to page 40)

SECTION NEWS

Edited by
Stanley Bindman
Jamison Plastic Corp.
71 E. Sunrise Highway
Freeport, New York.

High Impact Polystyrene Discussed At New York Section Meeting

Arthur M. Merrill

The New York Section held another highly successful meeting on April 15 at the Gotham Hotel. Over 85 members and guests attended the meeting which featured a talk on "High Impact Polystyrene" by E. L. Kropscott, assistant manager of plastics technical service, Dow Chemical Co.

After reviewing the history and development of Styron 475 high impact styrene, Mr. Kropscott noted that 300-550°F. is the normal range of cylinder temperatures for injection molding the material. However, prolonged exposure of the material to temperatures in the upper part of this range will result in a definite reduction in physical properties of the finished part. For example, increasing the molding temperature 400 to 550°F. can reduce elongation by one-half, and lower tensile and impact values. In addition, high plastic temperatures can result in excessively long cycles, sink marks, bubbles, silver streaks, warping, and color changes.

The molding pressure for Styron 475 will normally be in the range of 10,000-18,000 psi., but the lower the pressure in this range the higher will be the physical properties obtained. The speaker emphasized that mold temperature control is a very important factor with this material not only because of the effect on properties, but also because of the effect on appearance of the molded part. The critical mold temperature for Styron 475 is 160°F., and temperature below this point will give poor surface luster, non-uniform appearance, and prominent flow lines and weld marks. It is also necessary to control the temperatures of certain localized mold areas; for example, areas around gates may become excessively hot and require added cooling.

Mr. Kropscott urged that the molding of Styron 475 for products requiring dimensional stability follow these four rules: (1) use the proper amount of material; (2) fill the mold quickly; (3) seal off the mold after filling; and (4) avoid packing the material in the mold. Strain in molded parts can be relieved by annealing which often also raises the heat distortion temperature of the part.

In discussing the permanence of Styron 475 moldings, the speaker noted that cold temperature service greatly reduces the impact strength. Aging also has an adverse effect on properties, but here the type of environment plays an important part. Reductions in impact result from exposure to ultra-violet light, outdoor weathering, use of paints and cleaners, and continued stressing of parts in service.

In conclusion, Mr. Kropscott stated that future developments in high impact styrene should result in materials having better color ranges and retention, improved weathering properties, better heat resistance, and improved low temperature impact.

Rounding out the program was a talk on "How to Improve Reading Speed and Accuracy" by K. P. Baldridge, S. R. Gibson, and Ruth Machlin, all of the Reading Laboratory, Inc. Using slides to illustrate their talk, the speakers showed how the Laboratory's specialized training course in reading can greatly improve reading speed and retention.

Section president Saul Blitz presided over the meeting. In a brief business session preceding the talks there was a discussion of a possible golf outing in June; progress reports on the raising of funds and equipment for the plastics vocational high school course sponsored by the Section; and a preliminary announcement of plans for a film contest among the members. The speakers were introduced and thanked by program chairman Irving I. Rubin, Robinson Plastics Corp.

The meeting concluded with a drawing for door prizes contributed by Emenee Industries, Inc.; Fiberoid Doll Co.; Monsanto Chemical Co.; and Naugatuck Chemical Division, United States Rubber Co.

Continuing its active growth, the New York Section added the following six members during April: Joseph B. Chip, Plastic Molders Supply Co.; Lester Gabriel, Leaf Plastics, Inc.; Elizabeth D. Martin, Arnkurt Associate Engineers; Benjamin Sokol, Republic Aviation Corp.; Herbert Streifer, Model Plastic Corp.; and Jack Weiss, Catalin Corp.

Southern California Talk On Expanded Vinyl Plastics

Austin H. Herbst

Local Section Meeting

Mr. M. J. Kleinfeld, Head, Vinyl Compound Development, Naugatuck Chemical Division of United States Rubber Company, Naugatuck, Connecticut spoke on "Expanded Vinyl Plastics" before a group of 85 members and guests.

A review of expanded plastics, blowing agents and blowing processes with emphasis on the expanded vinyls was covered. Lantern slides picturing some of the processes involved in the production of expanded vinyls were presented along with samples illustrating the applications of expanded plastics.

Personal

A large group of Society of Plastics Engineers members and their wives attended the tenth annual conference sponsored by the Pacific Coast Section of the Society of Plastics Industries at Las Vegas, Nevada on April 8-10.

Round Table on Materials Handling Engages Attention of Detroit Section

Emil R. Gazdick

On April 20th., the Detroit Section held a technical meeting at the Rackham Memorial Building in Detroit.

The dinner was followed by a round table discussion on the subject of "Materials Handling." Our moderators were Mr. George Demorest of Wayne University, Assistant to the Director of Materials Management Center, Mr. John Totten, manager of plastic operations of the Ford Motor Co., and Professor G. E. Clark, Industrial Engineering Department, Wayne University.

During the first part of the session, Professor Clark showed a film entitled "Application of Motion Study" which showed a number of examples of better and easier ways to work. The film showed case histories of industrial operations before and after a time study analysis was made. In each case out-put was increased from 20 to 50% by a simple rearrangement of work and in some cases with the help of a simple inexpensive jig or fixture.

Professor Clark demonstrated the use of a Chronocyclograph, which means simply a time study graph of a cycle in performing a given operation. The demonstration consisted of attaching flashlight bulbs to one finger of both hands and recording the motion of a given assembly operation by means of a Land polaroid camera. The resulting picture gave a series of white dashes on a black background of the exact path of the hands during the operation. Each of these light dashes represented a fraction of a second and by adding them up it was possible to determine how long it took for the completed operation.

Mr. Demorest then discussed material handling from assembly operations to moving large and small quantities of raw material and finished parts.

Mr. John Totten reviewed some of the material handling problems in the plastics division of the Ford Motor Co. Solution to some of these problems were explained.

The meeting was attended by 50 members and guests. There were a number of requests for another meeting of this type for the near future so that foreman and supervisory help could be invited.

Plastics Pipe Is No Pipe Dream— Cleveland

F. A. Martin

By vote of the Board of Directors, the regular meeting date has been changed from the last Monday to the second Monday of the month. As a result the Cleveland Section met on March 30 and again on April 13 at the Spanish Tavern in Brecksville. Mr. John Merz of Yardley Plastics was the speaker on March 30 with "What Plastics Pipe is Doing for the Water Industry." This talk, while of a non-technical nature, presented a picture of how plastics pipe is being used to convey water and corrosive liquids, in most cases at a lower cost than for steel pipe. Approximately 75 million feet of plastics pipe was produced in 1952. The industry estimates this to be 2 to 3% of the potential for plastics pipe.

Dr. Henry Pace of the Goodyear Research Laboratory was the April 13 speaker. His topic was "Present-Day Plastics." Dr. Pace discussed the alkyd isocyanate resins and their application as foamed cores in radomes. He also discussed a new polyester rubber, Chemigum SL, which is similar to the German Vulcolan rubber. This is a type of rubber which is expected to give tire life of 75,000 to 100,000 miles. While the present price is high, large scale production should make it competitive with other types of rubber.

Ken O'Neill and John Thompson announced that they have formed a partnership, doing business as The Master Mold and Die Company, 14639 Lorain Avenue. They are specializing in the construction of injection and compression molds and die-casting dies.

Vacuum Forming Interests St. Louis

George A. Stein

The April meeting of the St. Louis Section was held at the Melbourne Hotel on the 28th, with approximately 50 persons in attendance.

The speaker for the evening was Mr. John Hoy, representing the Plastics Technical Service Department of the Dow Chemical Company, Midland, Michigan.

Mr. Hoy's talk covered the various phases of vacuum sheet forming of thermoplastic materials, with special emphasis to the use of Dow "Styron 475" sheet.

Since the subject is so timely and its methods so newly developed to rapid production uses, Mr. Hoy's talk was of special interest to the present.

His coverage of the subject went far beyond the usual talks and papers on vacuum forming in presenting and clarifying all of the troubles commonly encountered in this operation, as well as discussing the various allied equipment needed to set up a complete operation of this sort.

His discussion included trimming, methods of heating, stretch control by mold design, method of increasing production rates, mold construction, mold materials, and many other factors.

He also discussed the limitations of the process, and stated that it was not competitive with injection molding for many reasons, such as thickness control problems, and insert utility.

The talk was illustrated by use of a moving picture showing the equipment used, stretch resulting from various mold designs, and actual manufacturing techniques.

After a vigorous question and answer session the meeting was closed with the usual door prize drawing. This month's door prize was donated by the J. Graut Company.

Southeastern Ohio Talk on Atomic Energy

J. Chomicz

The Southeastern Ohio Section of the S.P.E. met on April 23 at the Beverly Hills dining room located west of Cambridge, Ohio.

President John Verburg has been transferred by the Continental Can Company from Cambridge to Milwaukee, Wisconsin. Vice President Paul Smith assumed meeting duties for the evening. It was pointed out to the attendance that a new Membership Chairman was needed immediately. A chairman is to be appointed within the coming week. A fairly detailed discussion on membership and how to increase it was held by the members present. One of the most thought-of ideas was to start a Section Project. A small portable show or display which can be used as an area educational program of S.P.E. contacting various school, technical societies, and any meeting where a show program would be desired.

The "membership address" supplied by National Headquarters was checked with the attendance and corrected.

The entertainment portion of the program consisted of a talk and a long interesting question-answer period on atomic energy. Mr. Phil Ramsey of the U.S. Bureau of Mines lead the discussion.

Diamonds in Your Own Back Yard Is Moral of Houston Industry Growth

William E. Wiese

The Houston section of the SPE met at the Frontier Inn on Wednesday, April 15. The program was preceded by a social hour and dinner.

"Diamonds in Your Own Back Yard" was the subject of a most interesting talk by Mr. Gordon Turrentine, Vice President of the South Texas National Bank of Houston. Mr. Turrentine spends much of his time keeping up with the industrial growth and the expansion of manufacturing facilities in the Houston area and in the whole state of Texas. He has just written an article for a forthcoming issue of the Texas Manufacturers Association magazine on "New Facilities for Plastics Intermediates." In cooperation with the Houston Chamber of Commerce he is responsible for the publication of the South Texas National Bank annual survey of the chemical industry in the Houston area, and frequent progress reports. Many of the "big name" companies in the petro chemical and plastics fields are included in these reports since they are represented by sizeable investments on the Gulf Coast. Mr. Turrentine drew from his experience to describe the industrial changes that are taking place around us.

In addition, we viewed two films sponsored by local plastics manufacturers. A film jointly sponsored by the Vector Manufacturing Company, the Blackwell Manufacturing Company and the Durable Plastics Company, extrusion and injection molders, illustrated the production of vinyl coated geophysical cable and injection molded styrene products. The L. C. Williams Company film showed the actual performance of their commercial preform machines and roving cutters in use with glass fibers.

April 1 through April 7 was designated by Governor Shivers as "Texas Industrial Week." The SPE was asked by the Houston Chamber of Commerce to represent the Plastics and Rubber Manufacturers in this area. Lew Williams and his committee arranged a display of items being produced in the Houston area and those of us who saw the SPE window in the Sakowitz Building will agree that they did an excellent job.

J. T. Pinkston is serving as president of the Houston section for the current year.

KEL-F Molding Told To Chicago Section

M. A. Self

Approximately 75 members and guests attended the dinner-meeting on April 8. A very informative talk entitled, "Techniques of Injection and Compression Molding on KEL-F" was given by Mr. Carmen Gianotta of the M. W. Kellogg Co. KEL-F is a registered trade-mark for the M. W. Kellogg Company's trifluorchloroethylene polymer. Some of the outstanding physical properties of this material are its excellent resistance to inorganic solutions, good resistance to organic solvents, zero moisture absorption and extremely good electrical properties. A brief description of its basic properties was given, such as the fact that it can exist in both an amorphous phase and a crystalline phase and undergoes this phase change at 211 C., which is called the transition temperature.

The material may be used for such items as electrical insulators, drum plugs for chemicals, valve diaphragms, etc. With the advent of a new plant, KEL-F will soon be in plentiful supply.

It will be remembered by many of the readers that Mr. Gianotta spoke on this same subject at the ninth SPE conference in Boston.

With the golf season getting into full swing, the Chicago SPE-SPI members are looking forward to the first golf outing to be held June 18 to 20 at Nippersink Manor, Genoa City, Wisconsin. Everyone attending is assured of a good time.

Cruver Manufacturing Company of Chicago have blueprint plans under way for a $650,000 one-story plant in Franklin Park. They hope to be in their new quarters by this fall.

H-P-M Speaker Visits Northern Indiana

James O. Martin

Mr. R. W. Powell of Hydraulic Press Manufacturing Company, Mt. Gilead, Ohio, was the featured speaker at the April 17th meeting of the Northern Indiana Section held at the Chamber of Commerce Building, Fort Wayne, Indiana.

Mr. R. W. Powell combined slides with a full discussion of pre-plasticizing in injection molding, including the many advantages of greater plasticizing capacity. Lower cost moldings are possible through pre-plasticizing due to larger shots, somewhat lower molding pressures, thinner sections, larger areas, deeper draws and stain-free parts. As a general overall result, the same piece part will be lighter and a larger percentage of these parts are marketable. A sample of pre-plasticized molding was presented by the speaker to each one attending.

An informal dinner meeting at the Manochio Grill and Restaurant preceded the meeting.

West New England Outlines Plastics Future

E. J. Sweeney

The April meeting of the Western New England Section was held at the Hotel Sheraton in Springfield, Massachusetts, on April 1st, 1953. A short business meeting was held immediately after the dinner. Mr. John Mallory, National Director from this section, reported on the recent National Director's Meeting. President Ed. Childs then introduced the speakers for the evening, Mr. Sandy Glick, and Mr. Ed Hillyer of Monsanto Chemical Company.

Ed Hillyer gave a brief outline of our plastics future in the 1980 eras, a la Buck Rogers. He then discussed the growth areas, in the markets, for polystyrene and styrene copolymers. The toy market, for example, should be expanded greatly by the improved impact types.

Sandy Glick then discussed the properties of the various types of polystyrene from the development engineering viewpoint. Mr. Glick pointed out the properties that would contribute to growth in use of styrene. An interesting discussion period followed.

Design of Nylon Topic at Rochester

Charles J. Williams

Mr. William C. Wall delivered an interesting talk on "End Use and Design of Nylon."

His talk covered a brief history of DuPont nylon's development from the synthesis of the first nylon type of polymer in 1934 and the first investigation of its possibilities as an industrial molding material in 1945. In contrast, he discussed the many applications which nylon finds today, pointing out the properties which are responsible for this widespread use. Mr. Wall's talk was illustrated by colored slides.

(More Section News on page 40)

O'Hara-Rowan Associates Formed

Harry F. O'Hara and Edward Rowan wish to announce the organization of O'Hara-Rowan Associates to be located, shortly, in the Bassett Building, 382 Springfield Avenue, Summit, New Jersey.

This organization is intended to assist in the proper design and development of Plastic Products, particularly in the Packaging Field. Present facilities include designing and model making and, in addition, they are in a position to take full responsibility for the manufacture of Plastic Products through their wide knowledge of the Plastic Industry.

Mr. O'Hara was Secretary-Treasurer, and Mr. Rowan was President, until recently, of the Dillon-Beck Manufacturing Company, Hillside, New Jersey, manufacturers of Plastic Products, including Packaging Fishing Tackle, "Wannatoys" and special devices for the Government.

Mr. Rowan is a member of the American Institute of Plastics Engineers. He is a director of the Newark Chapter of the SPE and has held offices as Secretary, Treasurer, and President of this Chapter during the past three years.

Batelle Establishes Information Service for Industry

A new technological information service has been established at Battelle Institute, Columbus, Ohio. The service is aimed at assisting science and industry in streamlining the costly and burdensome job of tapping existing published knowledge.

Finding out "what has gone before" is the obvious question a good research man must answer when he undertakes a study, Battelle Director Clyde Williams points out. With an estimated 60 million pages of technical matter being published each year, this has become a herculean task. "Our aim is to couple appropriate use of improved manual and machine documentation techniques with our long experience in the gathering and organization of research data."

"The end result we are striving for is a technical information center that will save time and money for scientists and research organizations through the elimination of much needless duplication of research effort. The opportunities for so doing are tremendous. Some estimates put the current annual cost of literature searching at 300 to 750 million dollars, or from 10 to 25 per cent of the total 3 billion dollars spent by the nation or research last year."

Riverdale To Handle Dry Colors

RIVERDALE PLASTICS DEVELOPMENT CORP. of 423 3rd Street, Jersey City, N. J. announces a line of dry colors for all thermoplastic materials. Standard colors are available from stock and matches for special colors or effects such as metallic, florescence and pearlescent are available on request.

Mr. Arthur GeWertz of 521 5th Avenue, New York City is handling the RIVERDALE line of colors for New York and New England and Mr. John G. Simmons, Plastic Equipment Co. Box 302, Ridgewood, New Jersey, is handling the line in New Jersey and Eastern Pennsylvania. Samples and price lists are available upon request.

Industrial Literature

New Magazine

First issue of a new pocket-size, three-color publication called "Chemmunique" is made available to the executives of chemical process industries by Atlas Powder Company. The publication, to be issued on alternate months, presents helpful information on new and old uses of Atlas chemical products and Darco activated carbons, written in non-technical fashion and illustrated with color cartoons.

Copies may be obtained without charge by writing to: CHEMMUNIQUE Editor, Atlas Powder Company, Wilmington 99, Del.

IMP

Improved Machinery Co., has recently published a new folder covering their complete line of equipment. Improved Machinery Co., Nashua, New Hampshire.

Stokes

The re-designed Stokes-Windsor Extruder is described in a bulletin offered by the Stokes Co. Write to John Kilb, John Mather Lupton Co., 420 Lexington Ave., New York 17, New York.

Mylar

Mylar Polyester film is the subject of a duPont Product Information Service bulletin, 17 pages in length, describing in detail the properties and suggested applications of Mylar film. Write to DuPont de Nemours, Public Relations Dept., Wilmington, Delaware.

Vacuum

"Economical Finishing with Vacuum Metallurgy" is offered by National Research Corp., 70 Memorial Drive, Cambridge, Mass.

Witco

The sixth edition of a catalogue giving complete information on the products, plants and technical literature of the Witco Chemical Co., may be obtained upon request on company letterhead to Witco Chemical Co., 260 Madson Ave., New York 16, New York.

Abrasive

"Wherever There's Industry" is a 32 page book containing 46 case studies on abrasive-belt methods. More than 100 illustrations. Free on request by writing Porter-Cable Machine Co., 23 Exchange St., Syracuse, New York.

Glass Mats

Oriented glass mats for plastics manufacturers. For information write Elwood J. Robinson and Co., 1111 Wilshire Blvd., Los Angeles, Cal.

Adhesive

Data on Polyethylene adhesive Arcco 980-21D can be obtained from American Resinous Chemicals Corp., 103 Foster St., Peabody, Mass.

Autoclaves

A 48 page bulletin on Blaw-Know autoclaves is obtainable from Blaw-Knox Co., Process Equipment Dept., Farmers Bank Bldg., Pittsburgh, Pa. Ask for catalogue 2413.

Ovens

A catalog of drying ovens for thermoplastics is available for Injection Molder's Supply Co., Pentor Bldg., Cleveland 13, Ohio.

Oriented Methacrylate

(Continued from page 22)

ORIENTATION AFFECTS PROPERTIES

The orientation of the sheet changes some of the physical properties, but not others. The table below gives some data for polystyrene, oriented polystyrene, methacrylate and oriented methacrylate.

Orientation of polystyrene produces a tough sheet which does not have the brittleness of normal polystyrene nor the dimensional change of plasticized sheet. It does retain the tasteless, odorless and non-toxic properties of polystyrene. These, and its chemical resistance, are the reasons for its use in the samples of battery binder strip, dishes, place mats, shelf covering, decorations and toys shown here.

WEATHERABILITY

An additional property which has not been fully explored is the improvement in weatherability of polystyrene.

We started roof exposure test of samples on April 26, 1951. This test is continuing, but a photograph made November 12, 1952, shows that after eighteen months' exposure at Hartford, no serious degradation had been encountered. Half the samples are exposed under glass and some are attached at one end to allow some flapping by the wind. All are periodically examined for crazing and bent to test for brittleness.

In addition to this outdoor weathering test, we have been conducting accelerated weathering tests in the Atlas Weatherometer, where it is usually assumed that an hour is roughly equivalent to 25 hours outdoor exposure. Some of our samples have been exposed for 2300 hours, or equivalent to more than 6 years without failure. Samples in the Weatherometer are exposed in an unstressed state as are those on the roof, but some additional tests, where the samples are formed in 2, 4 and 6 inch circles to induce stress other than that of orientation, are also showing that biaxially oriented polystyrene sheet has much greater resistance to weathering than the unoriented polystyrene.

Weathering tests of oriented methacrylate were not started as long ago as the polystyrene, but after 674 hours in the Weatherometer, test strips have shown no change.

Because of this apparent improvement in weatherability, we are selling some polyflex where outdoor weatherability is important.

To conclude, polystyrene and polymethyl-methacrylate extruded sheet have been continuously oriented in two directions and improved toughness has resulted. One of the control tests developed is the "unmolding stress," which may be used to indicate relative toughness, but may also be used to study polymer differences and temperatures of original orientation.

TYPICAL STRESS UNMOLDING RESULTS

	Transverse Psi	Longitudinal Psi
Polyflex		
Roll K5 (.015) Green	95	105
" J183 (.014) Peach	95	120
" J207 (.016) Blue	115	97
" R7 (.015) Gray	85	71
" BX (.012) Trans.	32	53
" #1-37 (.003) Trans.	123	71.4
" #268 (.003) Trans.	103	93.8
Methacrylate		
Roll 1-320 (.015)	148	87.6
" 2-335 (.020)	134	60.4
" 7-600 (.030)	89	22
" 1-200 (.008)	166	92

COMPARISON OF PHYSICAL PROPERTIES

	Polystyrene	Oriented Polystyrene	Polymethyl Methacrylate	Oriented Polymethyl Methacrylate
Tensile Strength Psi	5,000–9,000	7,000–12,000	7,500–10,000	7,000–9,000
Elongation %	1–3.6	8–18	2–10	2.4
Strength in Flexure Psi	8,000–16,000	Over 10,000	13,000–17,000	
Compression Strength	11,000–16,000	Over 7,500	12,000–18,000	
Impact Strength (Izod) Ft. # inch of Notch	.25–.5	Over 3.0	.4–.5	
Hardness (Rockwell)	M65–90	M80–95	M85–105	
Breaking Angle Degrees Bend Around 1" Mandrel	44°	180°+	78°	180°+

PLASTICS AROUND THE WORLD

(from page 34)

10) furane resins. Only 2) had good strength at 450 F after 192 hr. at 150 F. 6) and 7) were poor at 200F. 3) was best in plastic-to-aluminum bonds at –70 and 250 F. Strengths of aluminum-to-aluminum bonds at –70F were usually better than at 250F. This report contains a large amount of data in tables.

National Advisory Committee for Aeronautics
Technical Note 2778, September 1952
STRESS AND STRAIN AT ONSET OF CRAZING OF POLYMETHYL METHACRYLATE AT VARIOUS TEMPERATURES
by M. A. Sherman and B. M. Axilrod (21 pages)

The stress and strain at the onset of crazing of both general-purpose and heat-resistant grades of polymethyl methacrylate were determined at 23, 50, and 70C. The stress at the threshold of crazing was 80 to 95 percent of the tensile strength at all temperatures. The results indicate that a "critical-strain theory" for the threshold of crazing, as suggested by Maxwell and Rahm for polystyrene, is not applicable to methyl methacrylate. (Copies of NACA Technical Notes may be obtained free on request to the NACA, 1724 F St. N.W., Washington 25, D. C.)

SECTION NEWS

(from page 37)

Automatic Molding Is Described at Indiana Meeting

Philip A. Leonard

The February meeting of the Northern Indiana Section of the Society of Plastics Engineers, Inc., held on February 12, 1953 in the Chamber of Commerce Building, Fort Wayne, Indiana, was called to order by the Secretary-Treasurer, Mr. Philip Leonard, in the absence of both the president and vice-president.

Minutes of the previous meeting were then read by the Secretary-Treasurer and approved.

The speaker for the evening, Mr. S. S. Helliwell, Chicago District Sales Manager of the F. J. Stokes Machine Company, was then introduced by Mr. Leonard. Mr. Helliwell spoke on Automatic Molding and the Vacuum Metalizing of Plastic Parts.

A movie on Automatic Molding was then shown after which a discussion period was held.

Economics of Plastics Industry Discussed At Golden Gate

Richard M. Weber

The April meeting of the Golden Gate Section was held on the 29th at the New Rex Restaurant. After a dinner voted excellent by those present we were favored with a talk on "The Economics of the Plastics Industry."

Dr. R. H. Ewell of the Dept. of Industrial Economics, Stanford Research Institute was our guest speaker. If the predictions based on the recent past and present trends are fulfilled our industry has a bright future, indeed. Dr. Ewell quoted sources which predicated that the potentials of the plastics industry, even in the present state of development, are but slightly realized.

Mr. John Moore of Fiberglas acquainted us with some ambitious plans for a meeting in the near future. It is hoped that our work, products and endeavors will gain considerable public notice there.

Injection Molderscope

(Continued from page 28)

little of it—and believe it or not there are a good many shops that do not know what a heating cylinder failure is—you will find that machine start ups are watched over very closely by the supervisory personnel. You will find that the cylinder is set at a soaking heat of 250-300° for a period of at least 45 minutes or an hour. After this soaking time has elapsed, the heat is advanced to the desired operating setting and then operation is commenced as soon as the instruments indicate that the operating heat has been reached. This simple precaution, we believe, will eliminate 80% to 90% of all serious heating cylinder trouble on the basis of observations we have been making in various plants on various machines and with various types of heating cylinders.

One of the simple ways to avoid heating cylinder trouble deriving from the differential expansion between the hollow barrel and the solid bar of steel of which most heaters are made is to provide a time clock to start up the machines several hours before actual operation is commenced. The pyrometer should be set at a low heat approximately 250° (or 200°) if heat sensitive materials are used. At the end of the soaking time—and it does not make much difference how long this soaking time is, if the cylinder temperatures are low enough—it only requires a few minutes for the cylinder to come up to a safe operating heat. However, by that time, all of the thermal fatigue strains inside the cylinder have more or less equalized themselves and it is safe to apply the tremendous injection pressures which we commonly use. There is evidence that points to the fact that only one push of the injection plunger on a heating cylinder, when it is just at this critical stage in its expansion at a start up, is sufficient to permanently lodge material under the legs of a floating spreader or to start the familiar hair line cracks in the solid spreader. Once this damage starts at a single accident or oversight as the case may be, it becomes progressive and the heating cylinder is on the way toward a costly repair.

As long as the internal parts of a heating cylinder are intact and the pressure strains have not been added to the thermal strains at a critical time causing internal damage, a cylinder will purge easily. Once, however, you have **started** a crack or **started** material lodging under the feet of a spreader or **started** charring of the plastic on the outer wall of the heater, you are headed for trouble. It is very seldom, indeed, that anything can be done to purge out a heating cylinder that has started to "throw black" as the expression goes.

It is sometimes possible to trace burning to material lodged under the nozzle seat and in some cases, we have found that a fresh nozzle installed on a clean seat will eliminate burning marks which look exactly like a heating cylinder. In most cases, however, once black starts to appear (or brown streaks in the case of white), there is nothing for it but to take the heating cylinder apart find the cause of the trouble and start all over again. Very often, when the cylinder is opened up, there is nothing structurally wrong with the heater except a tiny bit of flash lodged in a thermal expansion spot such as a joint in a bolted heating cylinder or under the legs of a spreader in the case of cylinders where the spreader is inserted.

Thus, the simple precaution of allowing a one hour soaking period at 250° can be seen as an easy way to reduce your cylinder repair bills. This is not a new idea by any means, but a lot of shops need to be reminded of it!

Dynamic Properties

(Continued from page 19)

temperature; whereas, for polyvinylchloride the damping remains quite low over an extended temperature range. At the damping minimum, the modulus exhibits an inflection point above which it decreases at an accelerated rate. It is interesting to note that the addition of plasticizer changes the damping only slightly; whereas, the modulus is decreased considerably. Such data can be correlated with the processing characteristics of plastics, such as molding, extrusion and calendering. A low modulus-low damping material cannot be injection molded as readily as a low modulus-high damping material. On the other hand, calendering can be accomplished more satisfactorily with a material having a low damping value at the processing temperature. Finally, it should be pointed out that the creep or flow properties can be predicted from dynamic measurements.

Figure 9 shows the dynamic mechanical behavior of other types of plastic materials. Most of these curves can be readily interpreted in terms of the preceding discussion.

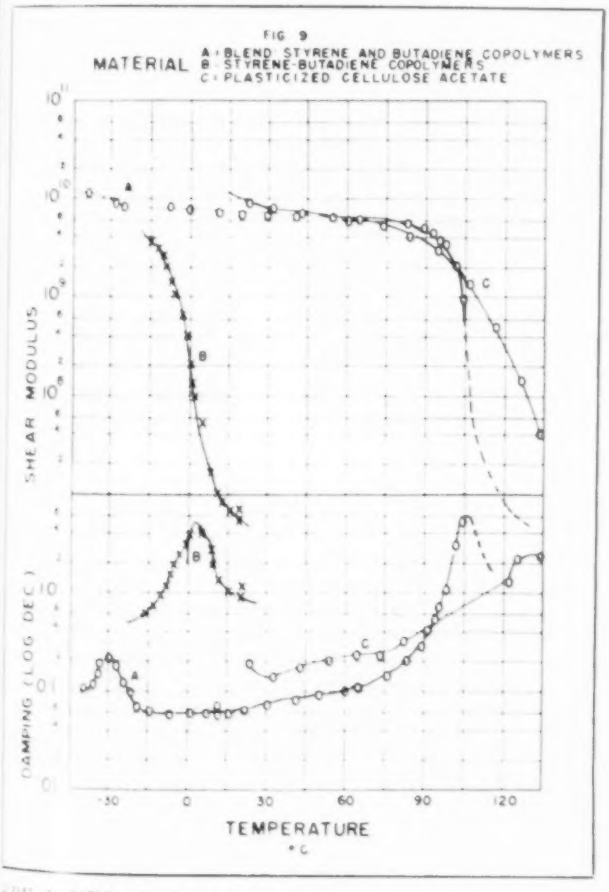
APPENDIX:

The equation for the shear modulus given in the text is an approximate value that is accurate to 2% for damping less than $\delta = 0.9$. The damping gives rise to a retarding force similar to the real modulus when a material is deformed. Thus, the total shear modulus is

$$G_T = \frac{1.42 \times 10^5 LI\,(4\pi^2 + \delta^2)}{CD^3 P^2}$$

lbs sq. in. for rectangular cross section.

FIG 9



This total modulus is related to the real and imaginary parts of the modulus by the equation

$$G_1 = \sqrt{G'^2 + G''^2}$$

where G' is the real part of the modulus, which is proportional to the potential energy stored during a deformation. G" is the imaginary part of the modulus and is related to the damping. The logarithmic decrement δ is related to these quantities by the equation

$$\frac{G''}{G'} = \frac{4\pi\delta}{4\pi^2 - \delta^2}$$

For small or moderate value of damping, this becomes the approximate relation

$$\delta = \pi \frac{G''}{G'}$$

The ratio G" G' is called the mechanical dissipation factor, and it is analogous to the electrical dissipation factor determined in electrical tests.

Another term used in dynamic mechanical testing is the specific damping capacity ψ: it is given by the equation

$$\psi = 2\pi \frac{G''}{G'}$$

Mold Temperature Control Book

Faster Injection Molding Cycles Thru Mold Temperature Control is the title of a 4 page bulletin published by the Sarco Company, Inc., Empire State Bldg., New York 1, N. Y. This interesting and well printed bulletin may be had on request.

Plastics Scrap
AND SURPLUS VIRGIN MATERIALS
• BOUGHT • SOLD
• CUSTOM REPROCESSED
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POLYSTYRENE • ACETATE
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Branch Office: 8 East Long Street, Columbus, Ohio • MAin 4877

Rubber-Phenolic

(Continued from page 13)

a 5 K.W. preheater to a pill temperature of 200 F. The mold is gassed 2 seconds after closing and the part cured for 2¼ minutes. In this instance, the application went to rubber-phenolics because of the shortage of aluminum for die casting. Rubber-phenolics offered a means of solving the problems for several fundamental reasons. The rubber-phenolic wheel does not wear out nearly as fast as the die cast aluminum wheel it replaced. Returns on the plastic wheel for one year was zero. There has never been a complaint of a broken wheel, and the rubber-phenolic wheel runs quieter.

Several special effects can be obtained from the rubber-phenolics. The utility light handle shown in Figure 7 has been given a good hard chrome with a mirror finish by the standard electroplating method for phenolics. The spray nozzles shown were given a base coat of lacquer to provide a base for the metallic finish. These parts were plated by the vacuum deposition method and the mirror finish obtained can be readily seen.

Radio cabinets can be molded from the flock-filled rubber-phenolics and then treated, by a process developed by P.M.I., to produce a felt or suede-like finish. The application of the various finishes shown does not affect the strength of the rubber-phenolic.

Figure 7. Special effects can be obtained by plating rubber-phenolic by electroplating or vacuum deposition of metal to provide a mirror finish.

Mold Castings

(Continued from page 15)

cessfully weld the castings with a nickel bearing rod such as Nirod 55 or Eutectic 24, others have been brazing the material with a 1600°F. melting point braze metal. In one case the weld rod blends quite well with the parent metal of the casting, in the other case the color or the braze metal is entirely distinguishable from the casting; however, where a fast, smooth operation is required, either type of procedure can be followed without difficulty.

To summarize the above; plain and alloyed iron castings have definitely found a home in the plastics industry, they can be produced quite inexpensively, they can be delivered in a short period of time, they usually require only a bench operation to finish, that is, outside of your allignig holes and steam channels, etc, and finally, the pattern equipment required for this work is relatively inexpensive. The combination of these four points is very much in demand and, I am certain, it will be even more so in the near future.

CLASSIFIED ADS

PLASTICS ENGINEER

Diversification of extruded Thermoplastic products line by well-established company located New Jersey metropolitan area creates excellent opportunity for man having some experience with rigid vinyls. Primary responsibility will be research and development. Please submit complete resume for prompt and confidential consideration to box # 1453, SPE Journal, 513 Security Bank Bldg., Athens, Ohio.

REPRESENTATIVES WANTED — Exclusive territories. Company manufactures complete line of materials for the plastic industry and for those who use plastics. Products include adhesives, mold release solutions, special coatings, and many other specialties. Materials also used by the glass, electronic, aircraft and several other fields including Army and Navy. Box 1953, Society of Plastics Engineers, Inc., 513 Security Bank Bldg., Athens, Ohio.

EXTRUDING CHEMICAL ENGINEER

Plastics engineer, thoroughly familiar with extrusion of polyvinyl and polyethylene compounds, has excellent opportunity as production and development man with plant specializing on electrical insulation extrusion. Permanent position, good prospects. Give complete resume also indicating last salary had. Applications will be treated confidentially. Box 2053, SPE JOURNAL, 513 Security Bank Bldg., Athens, Ohio.

For Sale

FOR SALE—VERY CHEAP—5 INJECTION MOLDS PLUS A GOOD QUANTITY OF COMPONENTS. MOLDS ARE FOR A 5" ROUND COMPACT—A FLAT CIGARETTE CASE—A SQUARE CIGARETTE BOX —A PIANO CIGARETTE BOX AND A 16 CAVITY MOLD FOR MIDGET WIND-UP CARS. PRICES AND ADDITIONAL INFORMATION UPON REQUEST. Box 269, Dept. W, Erie, Pa.

NOTICE TO THE PLASTIC TRADE:

MR. ROBERT KAGAN IS NOT IN ANY MANNER ASSOCIATED WITH US IN BUSINESS.

AMERICAN PLASTIC CORPORATION
DAVE SEGAL, PRESIDENT
2938 N. Halsted St.
Chicago 14, Illinois